COMPREHENSIVE PLANNING
DATA SOURCES AND APPLICATION

Prepared for: U.S. Air Force Directorate of Engineering and Services and Dept. of the Army HQ U.S. Army Corps of Engineers

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SEPTEMBER 1989

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CHAPTER 1. INTRODUCTION

Chapter 1

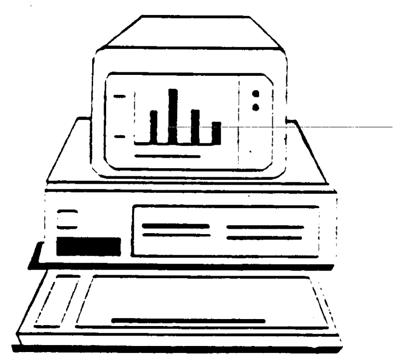
Introduction

A. PURPOSE OF THE BULLETIN/MANUAL

1-1. Guide for Data Collection.

a. Comprehensive planning is an increasingly complex process. Preparing a comprehensive plan often requires the collection of more data in greater detail than ever before at a specific installation. Requirements of Department of Defense as well as other federal, state and local regulations have increased the complexity of the data collection process. Planners face the challenge of gathering the highest quality information in the most efficient and effective manner. The planner has many options for the collection, application and display of data collected, and one of the challenges of data collection is identifying the reasonable limits of data collection for a specific planning task.

b. The purpose of this bulletin/manual is to provide planners with a useful guide for data collection activities. This bulletin/manual describes types of data which can be collected, potential sources for this data, their potential application and options for use of computers in data collection, application and display. The bulletin/manual focuses on the collection of data from outside sources (i.e., off-installation); in addition, the bulletin/manual relates primarily to installations and data sources located in the continental U.S. The bulletin/manual Is not Intended to be read cover-to-cover. The planner should refer to each data category as needed.



1-2. Using the Computer. The aerial photogrammetric mapping process is often used to update existing installation conditions maps as part of the comprehensive planning process. These mapping data bases then become the basis for the development of additional planning overlays depicting the graphic components of the plan. In addition to aerial mapping, other automated methods for data capture, manipulation and display are available to planners. This bulletin/manual seeks to address the use of computers in this mapping process as well as give an overview of computer graphic technology as it applies to comprehensive planning.

B. HOW TO USE THIS BULLETIN/MANUAL

1-3. Questions About Data Collection. As both a guide to the data collection and application process and a reference for installation planners, this bulletin/manual addresses several questions planners may have regarding data collection in the comprehensive planning process. These include:

- What data should be collected?
- Where do you get the data?
- How do you use the data?
- How do the data relate to other data?
- What are your options for display?

1-4. What data should be collected? To determine what data are to be collected, the planner should first identify the component plans that will be prepared or updated. Figure 1-1 outlines the kinds of data that may be required to complete each component plan. After selecting the data category(s), refer to the appropriate chapter and section of the bulletin/manual for guidance in collection of data in that category. The amount of data to be collected may vary depending upon whether the plan is initially being prepared or if it is being updated.

1-5. Where do you get the data? Each section lists sources of various data, including on-site, federal, state, local and regional sources.

DATA CATEGORIES	Natural Resources	Environmental Quality Protection	Land Use	Airfield, Air & Range Operations	AICUZ / ICUZ	Utilities Systems	Communications Systems	Transportation	Energy	Arch. Comp / Landscape / IDG	Long Range Facilities Development	Fire Protection	Contingency / Mobilization	Physical Security	Quality of Life Programs
NATURAL ENVIRONMENT															
Topography	●	●	●	●	●	●	●	●		●	●			●	
Geology	●	●	●	●		●	●								
Soils	●	●	●			●	●				●				
Hydrology	●	●	●			●	●					●			
Water Quality	●	●	●			●							●		●
Air Quality	●	●	●												●
Climate	●	●	●			●		●	●	●	●		●		●
Energy	●	●	●	●		●		●	●	●	●	●		●	●
Noise		●	●	●	●						●				
Vegetation	●	●	●	●	●					●			●	●	●
Wildlife	●	●	●	●	●										
BUILT ENVIRONMENT															
Archaeology	●	●	●			●	●						●		●
History	●	●	●							●					●
Visual Resources	●		●			●	●	●		●	●				●
Land Use	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Facility Conditions									●	●	●	●	●	●	●
Transportation		●	●					●	●	●	●	●	●	●	●
Utility Systems		●	●	●		●	●			●	●	●	●	●	
Operational Constraints	●	●	●	●	●	●	●	●			●	●	●	●	●
Comprehensive Plans & Studies	●	●	●	●	●	●	●	●	●			●	●	●	●
SOCIOCULTURAL ENVIRONMENT															
Economic Profile			●		●										●
Population Characteristics			●		●										●
Support Systems			●					●							●
Political Structure			●		●	●	●	●				●	●	●	●
Quality of Life	●		●					●		●					●

COMPONENT PLANS

Figure 1-1

Data Categories Related to Component Plans

1-6. What do you do with the data? Each data category section provides a brief discussion and definition of the data category, the data elements to be considered and the relationship of the data elements to the preparation of the component plan. This includes a discussion of application of the data in the overall planning process and how the information is used in the identification of planning and development constraints and opportunities. Refer to the Comprehensive Planning Approach and Process Bulletin/Manual for guidance on how to fit data collection and analysis into the overall comprehensive planning process.

1-7. How do the data relate to other data? All data categories have relationships and interdependencies to other data. Each data category section has a discussion of these interrelationships so that the planner can begin to see how each data category may influence others. These interrelationships are further displayed in summary constraints and opportunities mapping.

1-8. What are the options for display? Once the data are collected, various options exist for manipulation and display. Data can be displayed graphically or in a written format, and there are options for both manual and computer-generated data display in both the narrative and graphic format. Examples include a data base for future recall (e.g., listing of all organizations and their real property), the formulation of a spreadsheet (e.g., a list of all future space requirements related to current inventory) for "what if?" calculations, or the actual spatial mapping of the data as it relates to the installation in the form of planning overlays (such as soil types, land use or operational constraints). Chapter 5 specifically discusses computer application in the comprehensive planning process as well as options for computer data display.

1-9. Contents of the Bulletin/Manual. The bulletin/manual is organized as follows:

- **Chapter 1. Introduction.** This chapter provides an overview of the subject of data collection. It generally discusses the definition of data needs, collection methods, general applications, alternatives for display and updating procedures. The overall organizational framework for the discussion of each data category as it relates to the planning process is also discussed (i.e., natural, built and sociocultural environments).

- **Chapter 2. The Natural Environment.** Data categories that are related to the natural environment are identified, potential sources are listed, applications of the data suggested, relationships to other data categories are outlined and display alternatives are described including a link back to computer applications.

- **Chapter 3. The Built Environment.** Data categories that are related to the built environment are identified, their potential sources are listed, applications of the data are suggested, relationships to other data are categories outlined and display alternatives are described including a link back to computer applications.

- **Chapter 4. The Sociocultural Environment.** Data categories that are related to the sociocultural environment are identified, their potential sources are listed, applications of the data are suggested, relationships to other data categories outlined and display alternatives are described. including a link back to computer applications.

- **Chapter 5. Computer Applications to Comprehensive Planning.** An overview of computer applications in the planning process, including computer graphics, aerial mapping and options for data capture and manipulation, are discussed.

1-10. Terminology. Non-specific military terms have been used wherever possible in this document. In some cases, generic terms were devised to avoid using terms specific to the Army or Air Force. Please refer to the table below (Figure 1-2) for the specific Army and Air Force definitions of these generic terms.

GENERIC	ARMY	AIR FORCE
installation	*installation*	*base*
the Plan (product)	*the Installation Comprehensive Plan*	*the Base Comprehensive Plan (BCP)*
comprehensive planning (process)	*Installation Comprehensive Planning*	*Base Comprehensive Planning*
the Engineer	*Director of Engineering and Housing (DEH)*	*Base Civil Engineer (BCE)*
major command	*MACOM*	*MAJCOM*
Military Construction (MILCON)	*Military Construction Army (MCA)*	*Military Construction Project (MCP)*

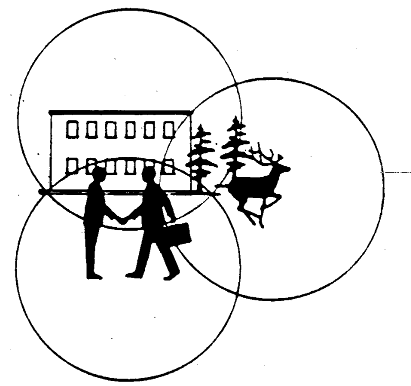
Figure 1-2

Terminology

C. DATA NEEDS AND APPLICATIONS

1-11. Data Needs.

a. Data needs will vary based upon the region and setting of the installation as well as the scope of the comprehensive planning effort. Data needs can be characterized into three broad categories which correspond to the three environments within which we live and work (Figure 1-3). These include:



- The Natural Environment
- The Built Environment
- The Sociocultural Environment

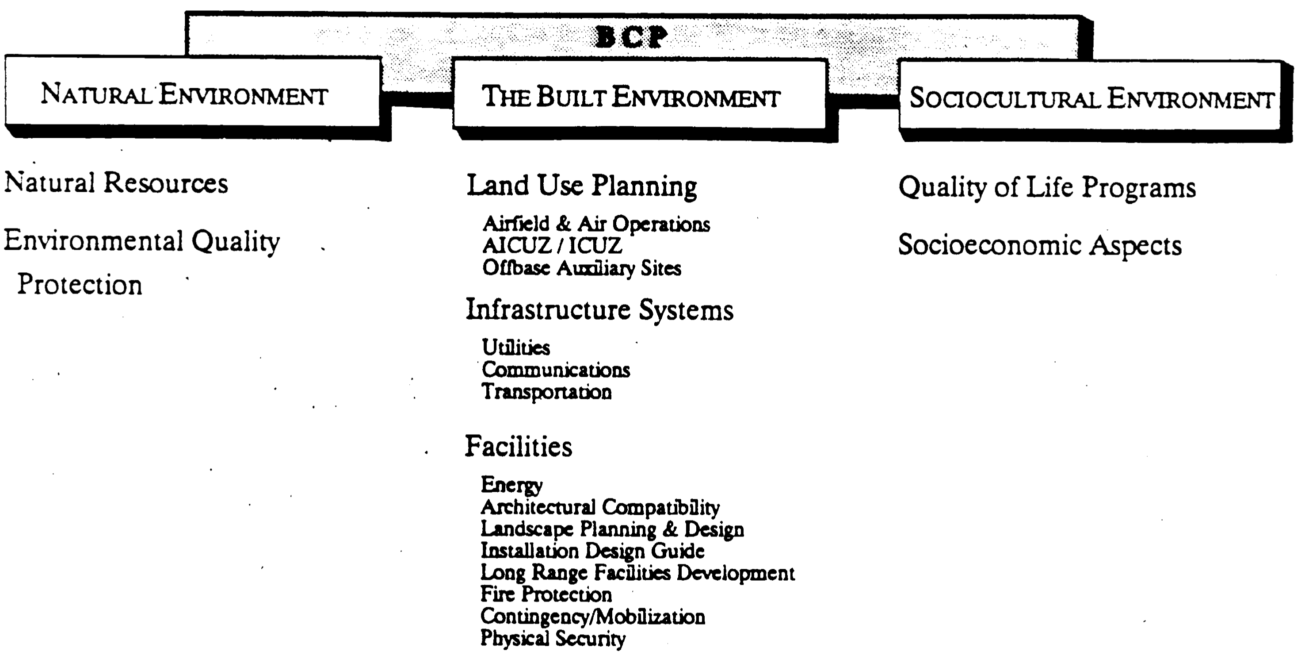


Figure 1-3

Component Plans Address All Three Environments

b. These closely interrelated environments comprise all categories of data. The natural environment provides the setting within which the built environment is constructed. Activities, institutions and relationships comprise the socioculture environment.

- **The Natural Environment** is. comprised of air, water, land and biological resources. (See the Environmental Quality Protection Planning Bulletin/Manual for additional information on data requirements related to the natural environment.)
- **The Built Environment** includes buildings, utilities, transportation facilities and all other elements introduced into the natural environment by humans.
- **The Sociocultural Environment** is comprised of those institutions, systems, activities, and relationships that affect and characterize the day-to-day lives of the members of the community.

1-12. Data Application. The comprehensive planning process requires data in a wide range and at various levels of detail. Data categories fall into the three broad categories of natural environment, built environment and sociocultural environment. Data are collected for each category as needed and interpreted either as opportunities or constraints to planning and construction. Opportunities and constraints for the natural, built and sociocultural environments. must be synthesized into a composite of information to aid the planner in defining the development suitability of available lands, which will guide land use decisions and facility development (Figure 1-4).

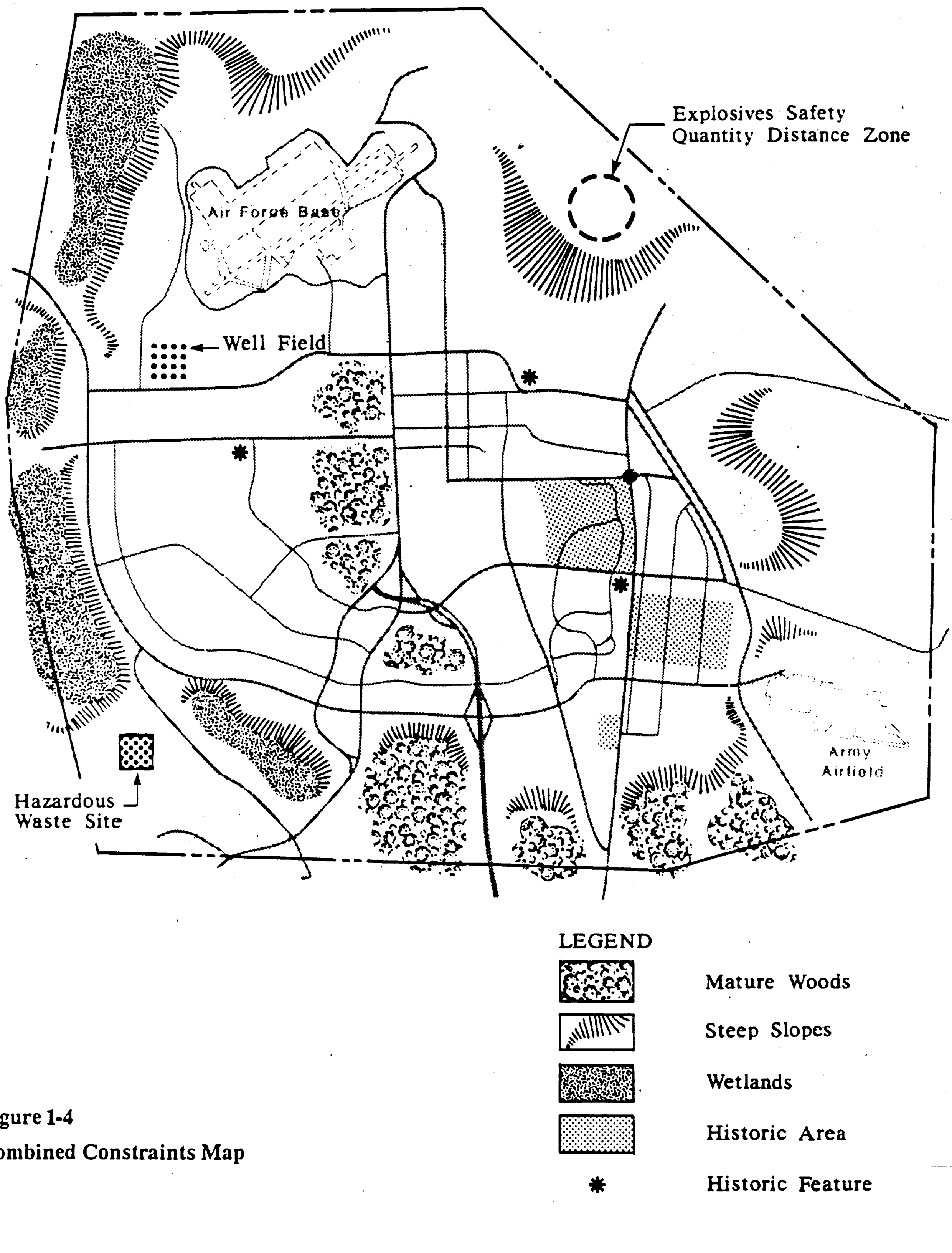


Figure 1-4
Combined Constraints Map

1-13. Data Synthesis. Coupled with a summary of development suitability are programmatic and functional requirement summary information. Together, these major information summaries provide the basis for the development of comprehensive plans. From this combination of data-based opportunities and constraints, the installation planner can explore alternative planning concepts, evaluate these alternatives and select a "preferred alternative" planning concept (Figure 1-5). The preferred alternative is then evaluated in detail and refined as the final plan. (See the Comprehensive Planning Approach and Process Bulletin/Manual for a complete discussion of the planning process.)

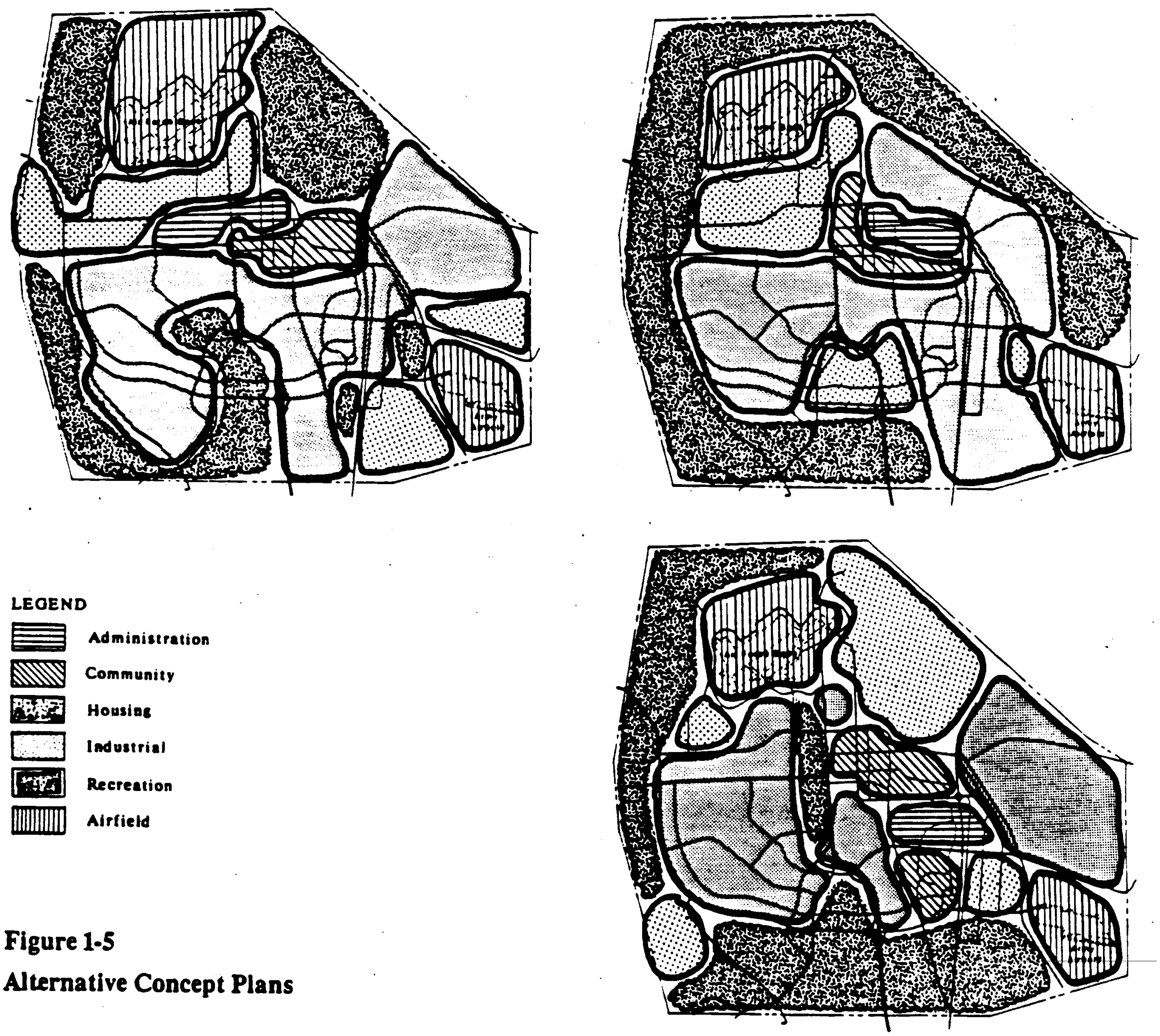


Figure 1-5
Alternative Concept Plans

1-14. Scales of Planning. Comprehensive planning should be viewed as occurring at three different levels or scales (Figure 1-6): the entire region, which is addressed in various community comprehensive plans addressing relationships between the installation and the surrounding community in the natural, built, and sociocultural environments; the installation level, which is generally the scale of planning that is addressed by the comprehensive plan; and the site level, which is dealt with in the Small Area Plans portion of the Long Range Facilities Development Plan, Project Books/Project Development Brochures, and DD Forms 1391. Figure 1-7 shows the data categories that relate to each planning level.

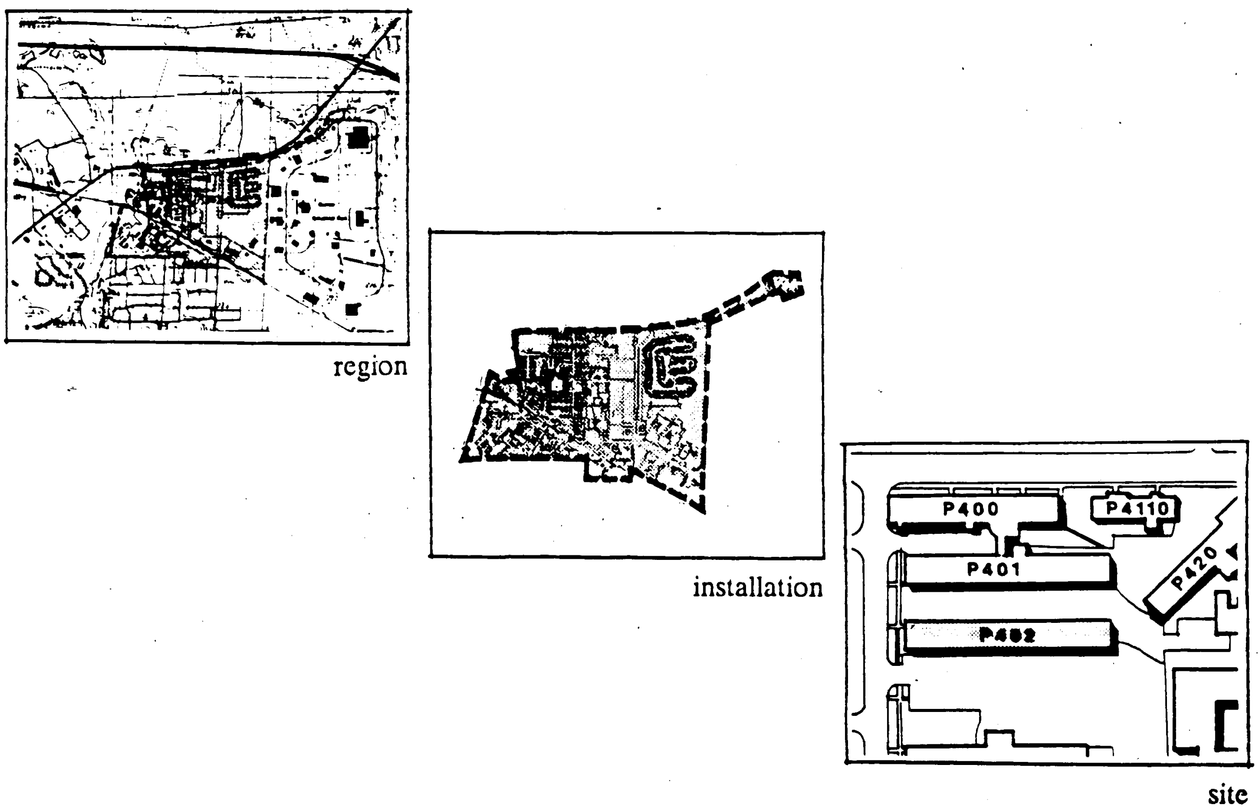


Figure 1-6
Scales of Planning

DATA CATEGORIES	PLANNING SCALE: Regional Level	Installation Level	Site Level
NATURAL ENVIRONMENT			
Topography	●	●	●
Geology	●	●	●
Soils	●	●	●
Hydrology	●	●	●
Water Quality	●	●	
Air Quality	●		
Climate	●		●
Energy		●	●
Noise		●	●
Vegetation		●	●
Wildlife	●	●	●
BUILT ENVIRONMENT			
Archaeology		●	●
History	●	●	●
Visual Resources	●	●	●
Land Use	●	●	
Facility Conditions			●
Transportation	●	●	●
Utility Systems	●	●	●
Operational Constraints		●	●
Comprehensive Plans & Studies	●		
SOCIOCULTURAL ENVIRONMENT			
Economic Profile	●		
Population Characteristics	●	●	
Support Systems	●	●	
Political Structure	●		
Quality of Life	●	●	

Figure 1-7
Scales of Planning Matrix

D. DATA COLLECTION METHODS

1-15. Data Collection Methods. Data collection can be accomplished through on-site reconnaissance, personal interviews, telephone calls, and by computer via modem. In all cases, check in-house data before approaching outside sources. When using outside sources, be sure to get the most out of each visit or telephone call. To save time for the data collector as well as the source, determine ahead of time all the information you may need.

1-16. On-site Reconnaissance. On-site reconnaissance data collection involves personal observation of installation conditions. Examples of on-site reconnaissance include land use surveys, facility evaluation, archaeological investigations, and traffic counts. Before going into the field, make a list of the conditions that need to be checked or observed. Take notes -- what seems obvious in the field will not be as obvious two weeks later in the office. Photographs can help document personal observations; be sure to record what the photographs depict as they are taken.

1-17. Personal Interviews. Follow these steps to conduct personal interviews:

- Evaluate the data available in-house at the installation before approaching outside sources.
- Begin all data gathering efforts by ordering Focal and state agency directories and a local phone directory for your installation area.
- Annotate the data source lists included in this manual with source names, addresses and telephone numbers which make the sources area-specific using the local telephone directory and state agency directory.
- Write a letter of introduction to each source you will require data from to explain the purpose of your visit (i.e., your project) and outline the specific information you will be seeking.

- Follow up the letter with a telephone call to set up an appointment. For efficiency's sake, group appointments by location. Prepare your list of questions before arrival at each source/site.

- Upon returning to your office, inventory data and note data "gaps." indicate which data categories may require further investigation.

1-18. The Telephone Method. The telephone method of data collection requires that you have access to local and state agency directories and a local phone directory for your installation area. Follow the steps below to collect data by telephone:

- Evaluate the data available in-house at the installation before approaching outside sources.

- Annotate the data source lists included in this manual with source names, addresses and telephone numbers which make the sources area-specific using the local telephone directory and state agency directory.

- Verify data sources by telephone. Once the source is located, interview the source by telephone using an introduction statement describing your project and data needs by category.

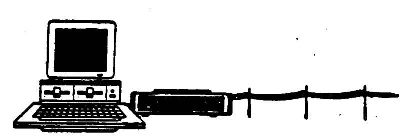
- Ask specific questions related to each data category. If data are not available, be sure to ask this source to recommend another source.

- Record the interview and ask what data/sources are available. Preprinted forms may be used.

- Make arrangements for the data to be sent as required.

- Note data gaps and categories which may require further investigation.

1-19. Computer Access Method. The computer access method of data collection can include retrieval of data from a wide range of sources via a modem. Potential available computer data bases are described in Chapter 5.



E. DATA AND SOURCE UPDATE PROCEDURES

1-20. Source List Update Procedure. The following steps are suggested to keep source lists up to date:

- Keep records of all telephone conversations and keep a personal written list of contacts. This list should be updated with each conversation and for each project. (This can be accomplished manually or with a computerized data base.)
- Organize a list of contacts by project area and by major topic (e.g., key contacts for soils maps in Baltimore-Washington area).
- Request to be put on the mailing list of major sources to be notified of personnel changes.

1-21. Data Update Procedures. The storage of data in-house permits easy access and retrievability. However, most data require periodic updating. The following procedure is recommended to occur concurrently with the comprehensive planning process to achieve the greatest efficiency.

- Existing data bases (library, individual data files, computerized data) may exist in-house at the installation. Evaluate the available data before requesting updates.
- Keep records of all sources of data. Data can be stored in computer files depending upon the type of hardware and software in use. Some federal sources will automatically send computer files updates of the desired data; others may require data retrieval.
- Data storage and updating may be possible at installation libraries as data is collected and updated on a regular basis.
- Request to be placed on mailing lists of major sources. Agencies such as the National Oceanic and Atmospheric Administration (NOAA) and the Federal Emergency Management Agency (FEMA) will automatically send updated "paper" data such as climatological data and flood plain maps if the installation planner is on the mailing list.

F. DATA CATEGORIES ORGANIZATION

1-22. Planning Data Categories.

a. The Comprehensive Planning Data Bulletin/Manual presents discussions of 25 planning data categories. These categories range from topography to political structure with each falling under one of three headings: (1) the Natural Environment, (2) the Built Environment, and (3) the Sociocultural Environment (see Figure 1-8).

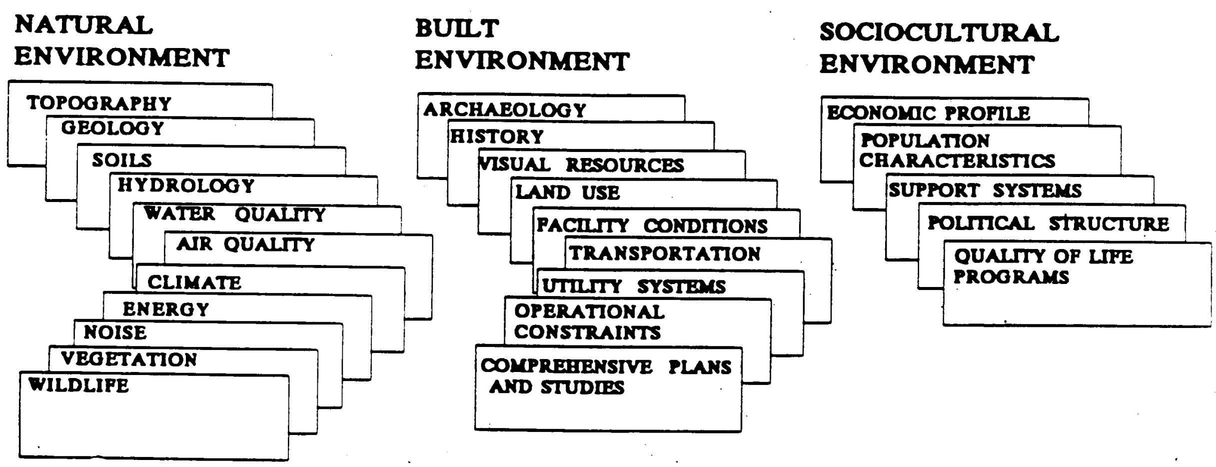


Figure 1-8
Data Categories Organization

b. Discussion of each category is intended to describe the basic information and key issues a planner should consider when collecting data for comprehensive planning. Such information is designed to help planners in formulating steps and questions in the collection process. Each data category review includes the following elements:

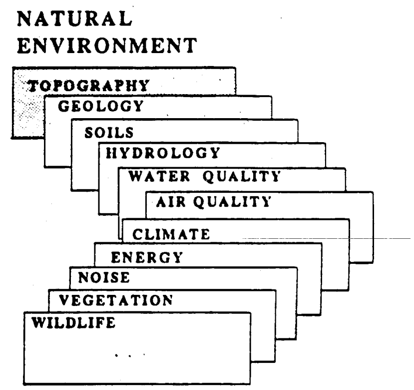
- A definition of the data category
- A discussion of how the data may apply to the planning process
- A description of how each data category correlates to other data categories
- A listing of potential data display alternatives A listing of potential data sources.

CHAPTER 2. THE NATURAL ENVIRONMENT

Chapter 2

The Natural Environment

A. TOPOGRAPHY



2-1. Definition. The basic land form or topographic structure of a site is a resource that strongly influences the location of land use functions. As a basic tool for' planners, topography maps provide the foundation for the site analysis that leads to the Land Use Plan and eventually to detailed site plans. Topographic data, in combination with other site factors, can be interpreted as either an opportunity or a constraint to development. Slope and landform are the primary topographic factors.

2-2. Data Application.

a. Topographic data is primarily used at the installation planning level to determine development opportunities and constraints. A quality topographic base map of the installation is essential for conducting site analysis activities. For example, areas with steep slopes or poor drainage may be judged as unsuitable for development. A general topographic understanding of the vicinity of the site is also important in analyzing drainage and visual relationships between installation and off-installation uses and areas.

b. General topography maps may be used to describe the vicinity and region. The topography of the region can usually be described visually by a quality map which shows major and minor rivers, streams and wetlands, as well as the major highways, roads and streets. These linear systems, when mapped, usually define the basic geography (landforms) of an area.

2-3. Relationship to Other Data. Topography and terrain features relate to soils, geology, surface hydrology, and vegetation. soils on slopes tend to have better drainage than in the lowlands because of the lower groundwater table. Topography relates to geology in that., topographically steep or rugged areas, knobs, or ridges are generally underlain by hard rock. The amount of vegetative cover is directly related to the topographic relief and thickness of the soil cover as well as site orientation and rainfall characteristics. Flood plains and other wetlands types can be found in topographic lowlands.

2-4. Data Display Alternatives.

- Computer-based Digital Terrain Models (DTM)
- Aspect maps (illustrating slope orientation)
- Site sections
- Planning maps
- Slope analysis maps (Figure 2.1)
- Slope tables

2-5. Data Sources.

a. Federal:

- U.S. Geological Survey
  - 7 1/2 min. quad maps, 1:24000 scale
  - Topographic maps at 1:250,000 scale
  - State maps at 1:500,000 scale
  - Shaded relief maps
  - Orthophotoquad maps
  - Digital cartographic products (U.S. Geo Data)

b. State:

- Geological Survey
- Department of Natural Resources
    - U.S.G.S. maps
    - State topographic maps

c. City/Local:

- Planning Office or Public Works Department
    - Topographic maps of land use plans
    - Topographic texts of land use plans
    - Aerial photographs
    - Local flood plain information

d. Commercial:

- Landsat
- SPOT

e. Additional Sources:

- Regional Council of Governments
- Regional Planning Agency
- County Planning Office

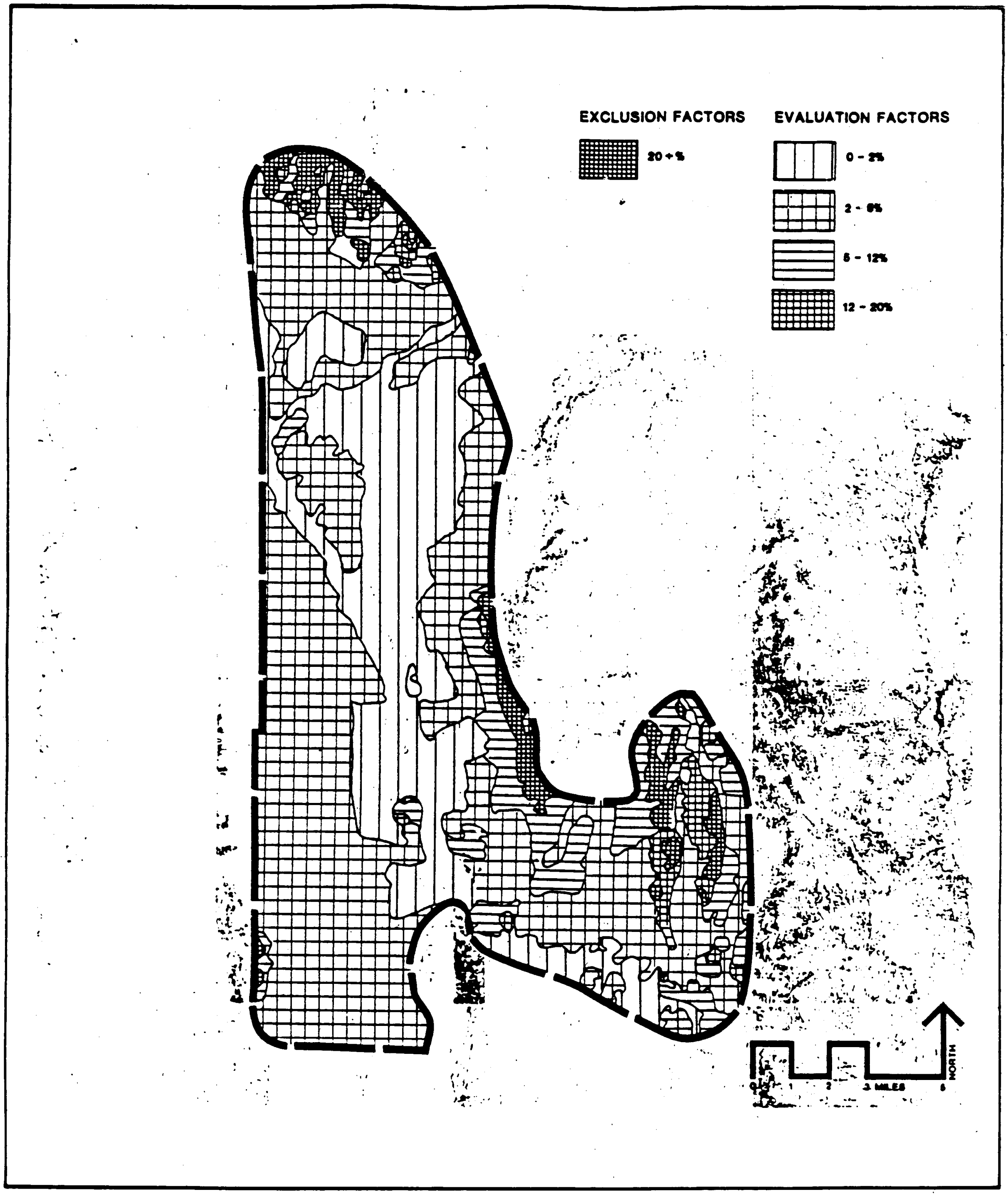
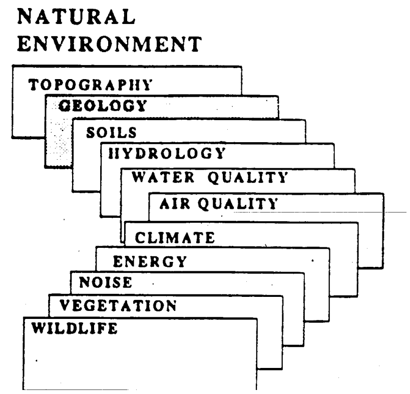


Figure 2-1
Slopes

B. GEOLOGY

2-6. Definition. The comprehensive planner is principally concerned with the engineering and environmental aspects of geology. Engineering properties of geologic materials can directly influence the siting of large buildings, roads, runways, bridges or other major structures. Environmental geology ideally considers all geologic influences, including engineering aspects and focusing on mans impact on natural geologic processes and vice versa. This includes the geologic stability of construction sites; water supply sources; occurrence, recharge and quality of groundwater; and natural hazards (e.g., earthquakes, tsunamis, floods and landslides). The planner can use geologic information to define both quality construction sites and sensitive environmental geology areas. Primary factors to consider in geology are depth of bedrock, groundwater (aquifers), and geologic hazards.



2-7. Data Application. Site-specific geologic data are available primarily through on-site drilling and surveying. Geologic formations can generally be located through analysis of published statewide and regional geology maps, but the limits and depths of geologic features can be estimated only within broad ranges. General comprehensive planning guidelines can be drawn from geologic characteristics described in geologic survey publications. At the installation and regional scale, published geologic maps, surveys, and reports are the most readily available and applicable. The level of detail required at the installation and regional scale is similar to that offered in statewide geology documentation.

2-8. Relationship to Other Data.

a. Relationships exist between bedrock types and the soils that overlay them, although soil composition and thickness varies with the geologic history. and parent material. Surface geology can be related to topography; topographically steep or rugged areas, ridges, and knobs are generally underlain by hard rock such as granite and have thin soil cover.

b. Surface geology also affects vegetation and land use. Rough terrains have thin soil cover that will not support healthy vegetation growth. These areas may be excellent for mining and related mineral production activities. Thick surface soil covers are usually excellent sites for crops or pasturelands. Surface geology is related to surface water flow in that infiltration is directly related to the amount of water available for streams and the development and size of drainage patterns.

c. Bedrock geology is related to the occurrence of groundwater and the potential for groundwater pollution. Crystalline hard rocks are extremely poor aquifers, but they may cause underground lakes by trapping underground water flow. Sedimentary rocks generally yield considerably more water to wells and are important sources of groundwater in some areas.

2-9. Data Display Alternatives.

- Depth to bedrock
- Geologic types (Figure 2-2)
- Geologic hazards

2-10. Data Sources.

a. Federal:

- U.S. Geological Survey (U.S.G.S.)
  - Land resource surveys: geologic, geophysical maps, geotechnical maps (1:125,000 scale), reports
  - Mineral resource surveys Energy resource surveys
  - Offshore geologic surveys
- Soil Conservation Service

b. State:

- Geological Survey
- Department of Natural Resources
  - U.S. geologic, energy and mineral resource maps/surveys
  - State geological maps
  - State and county-wide energy and mineral resource maps
  - Geologic structure maps

c. Regional:

- Regional Planning Agency
- Council of Governments
  - Geologic map, text from Land Use Plan
  - Mineral resource information
- County Planning Agency

d. Additional Sources:

- Utilities Authority/Commission
- Installation Environmental Division

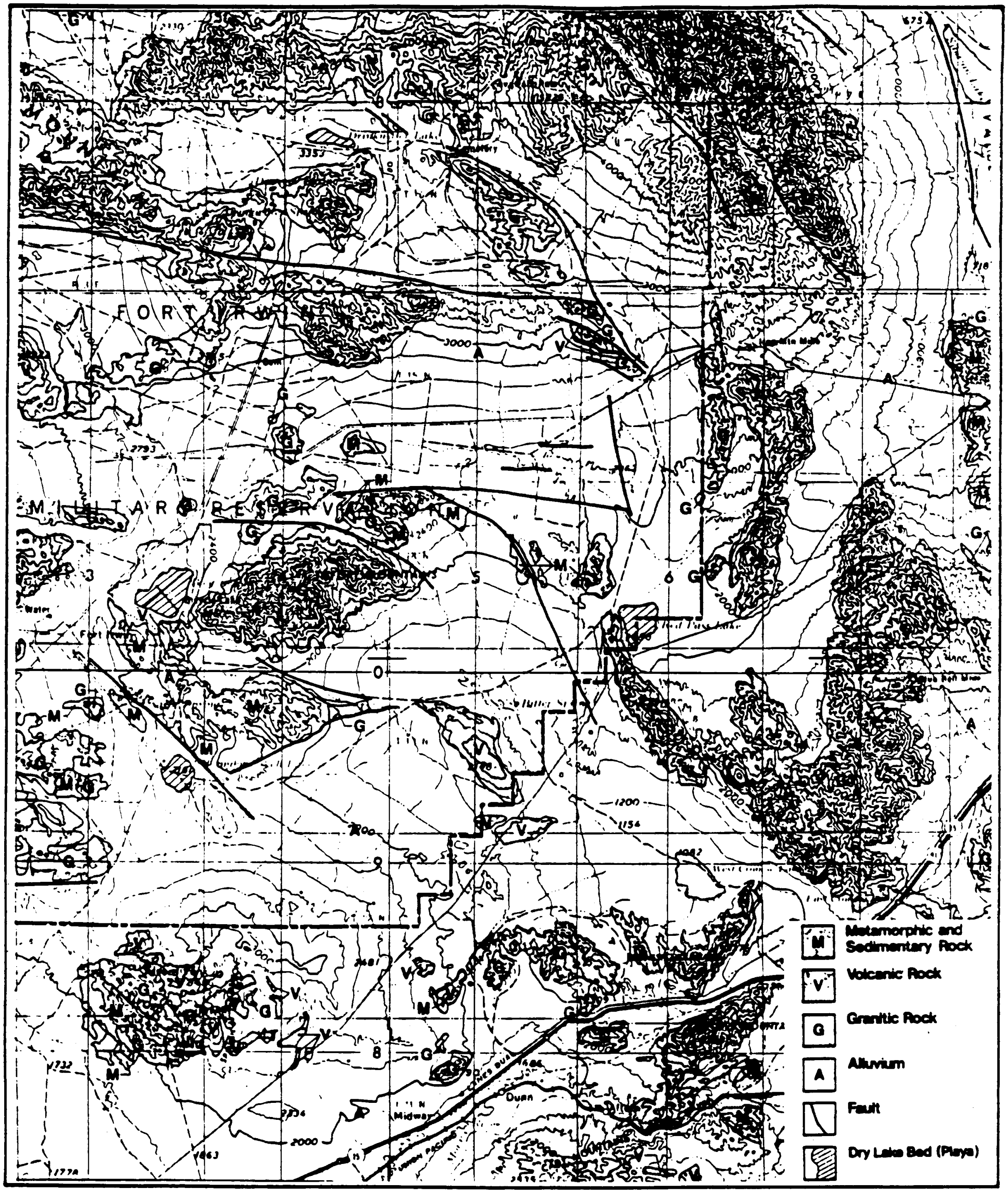
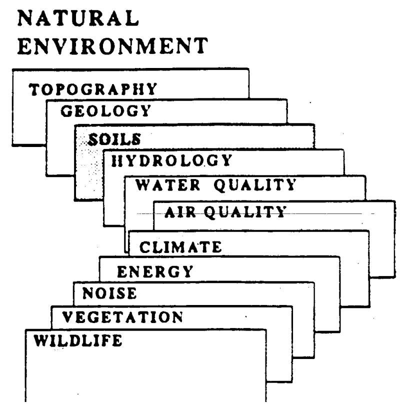


Figure 2-2

Surficial Geology

C. SOILS



2-11. Definition. The comprehensive planner is concerned with both the potential uses of soils and the properties of soils that affect construction activities. A soil survey and soil analysis of the construction-related characteristics of soils will aid the planner in determining the best use of an area and the relative suitability of an area for a particular activity or facility. The primary soil factors to consider in planning are productivity, erodibility, permeability and high water table, elasticity, shrink/swell potential, and bearing strength.

2-12. Data Application.

a. County or regional soil surveys and soils data should be on file in the installation natural resources office or can be obtained from the county office of the Soil Conservation Service. All installations should have had - a detailed installation soil survey performed unless there is a county soil survey that is suitably detailed. This information provides the planner with a basic set of land use siting criteria related to both the engineering properties and the best uses of soil types in an area.

b. Major facility construction should be preceded by adequate site-specific soil borings and tests. Such action ensures the proper location and structural design of structures and landscape features, resulting in potentially lower construction and maintenance costs.

2-13. Relationship to Other Data.

a. Soils can be indicators of the geological parent material (bedrock) they overlie. Topographically steep areas generally have thin soil layers and can have high erodibility potential. Valley bottoms along rivers and streams may have thick soils with high agricultural use potential. Hydrologic actions, both surface and subsurface, have direct impacts on soil conditions; permeability, elasticity, and shrink-swell are all fluid related. Vegetation cover and type are directly influenced by soil conditions. Soil conditions often determine potential beneficial land uses, the siting of training facilities and the activities allowed, and the siting of major structures, especially in regard to building, transportation and utility systems.

2-14. Data Display Alternatives.

- Soil types/classifications maps (Figure 2-3)
- Soil suitability maps
- Soil boring locations

2-15. Data Sources.

a. Federal:

- Soil Conservation Service (S.C.S.)
  (check local county field office)
  - County S.C.S. soil surveys
  - Soils interpretation
  - Soils capability texts

b. Regional:

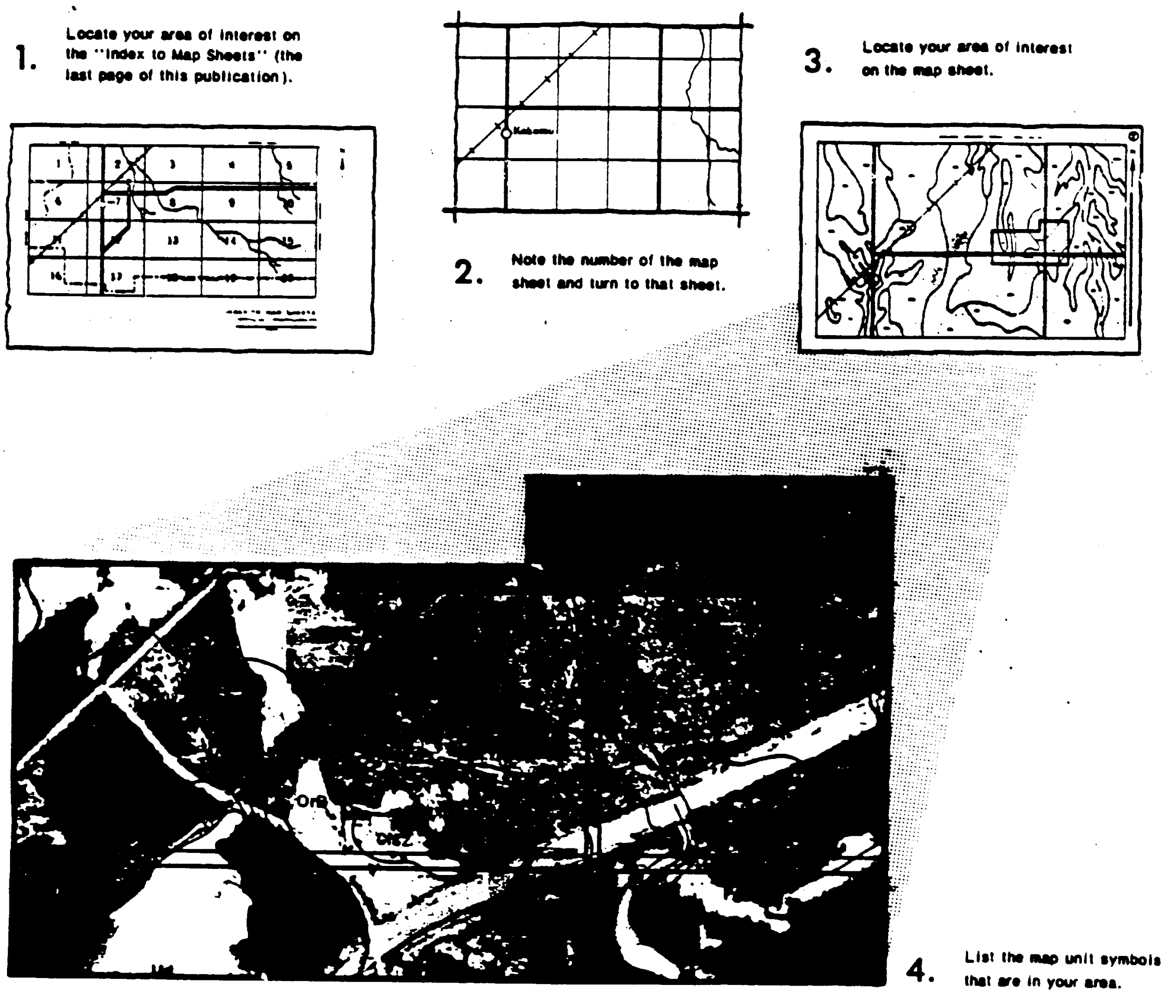
- Regional Planning Agency
- Council of Governments
  - Soil surveys
  - Soils component of regional master plan

c. City/Local:

- City Planning Agency
  - S.C.S. and other soil surveys
  - Soils component of master plan

d. Additional Sources:

- State Conservationist, S.C.S.
- State Department of Natural Resources
- University Geological Surveys
- U.S. Department of Agriculture Cooperative Extension Service
- Installation Environmental Division



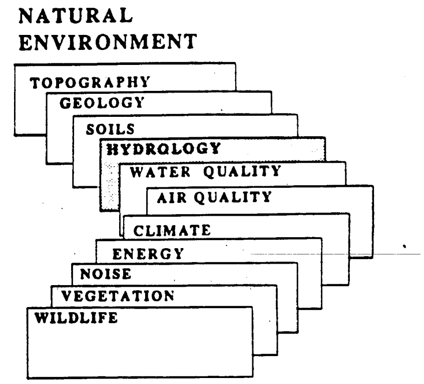
Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
AaB: Ailey	Moderate: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
AaC: Ailey	Moderate: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
Bh: Bibb	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, flooding.	Severe: wetness, flooding.
CeB: Cecil	Moderate: too clayey.	Slight	Slight	Moderate: slope.	Moderate: low strength.	Slight.
CfC2: Cecil	Moderate: too clayey, slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, low strength.	Slight.

Figure 2-3

Soils Map & Table

D. HYDROLOGY

2-16. Definition. Hydrology for the comprehensive planner concerns the properties, distribution, and circulation of water. This includes not only water on the surface of the land but also in the soil, underlying rocks, and atmosphere. Though generally seen as a positive natural resource, water can act as a distinct development constraint in its various forms and locations. Among the primary hydrologic planning factors to note are surface features, groundwater, flood plains, wetlands, swales, watersheds, and stormwater management.



2-17. Data Application.

a. Surface and subsurface hydrologic features must be mapped as accurately as possible in order to determine site-specific development opportunities and constraints. Surface water features are most easily recognized, but flood plains and subsurface hydrologic features arc also important in planning. Natural drainage patterns can be used to divide the site into development modules based on environmental factors. The creative and sensitive use of water features and resources is most appropriate at the small area plan level.

b. Regional hydrology maps can show major water-based interdependencies of sites for planning purposes. At a regional scale water-related issues include quantity flow and quality; development and open space relations of surface hydrologic patterns; and watershed development activities that affect installation sites.

2-18. Relationship to Other Data.

a. Hydrology, geology and climate are interrelated. Stream flow characteristics are controlled by both climatic and geologic factors. Precipitation, evaporation and transpiration are climate-based, while permeability and topography are geologic factors. Vegetation types and densities can also affect hydrology, particularly run-off. The discharge of a stream and permeability of the geologic materials will determine the amount of water exchange between ground and surface waters.

b. Water quality is directly related to hydrologic factors in the comprehensive planning context. The distribution of surface water has an influence on archaeologic and historic resources, since development traditionally occurred along streams and rivers. Surface and ground water supplies are criteria in selecting agricultural and industrial as well as recreational land use locations. When choosing land uses, consideration must be given to the problems of polluting water supplies. Industrial, agricultural and especially landfill sites have the potential to damage both surface and groundwater supplies. For a more complete discussion of water quality, see section 2-21.

2-19. Data Display Alternatives.

- Computer-based models - hydrologic/runoff/water budget (also in numeric table form)
- Hydrologic feature mapping - open water/drainage patterns/wetlands/flood plains (Figure 2A)
- Depth to water table

2-20. Data Sources.

a. Federal:

- Water Resources Division, U.S. Geological Survey
- Federal Emergency Management Administration (FEMA)
  - Hydrologic maps and texts
  - Maps/texts of groundwater sources
  - Maps of aquifers
  - Flood plain maps
  - Streamflow data
- Aerial photography
- Soil Conservation Service
- U.S. Army Corps of Engineers

b. State:

- Geological Survey
- Department of Natural Resources
- Department of Environmental Regulation
- Water Survey Division/Water Control Board/Department of Water Resources
  - Hydrologic maps and texts
  - Maps/tests of ground water sources
  - Map location of aquifers
  - Flood plain maps

c. Regional:

- Regional Planning Agency
- Council of Governments
  - Hydrology section of regional master plan
  - Flooding and water resource plans
- Regional/Municipal water supply utilities

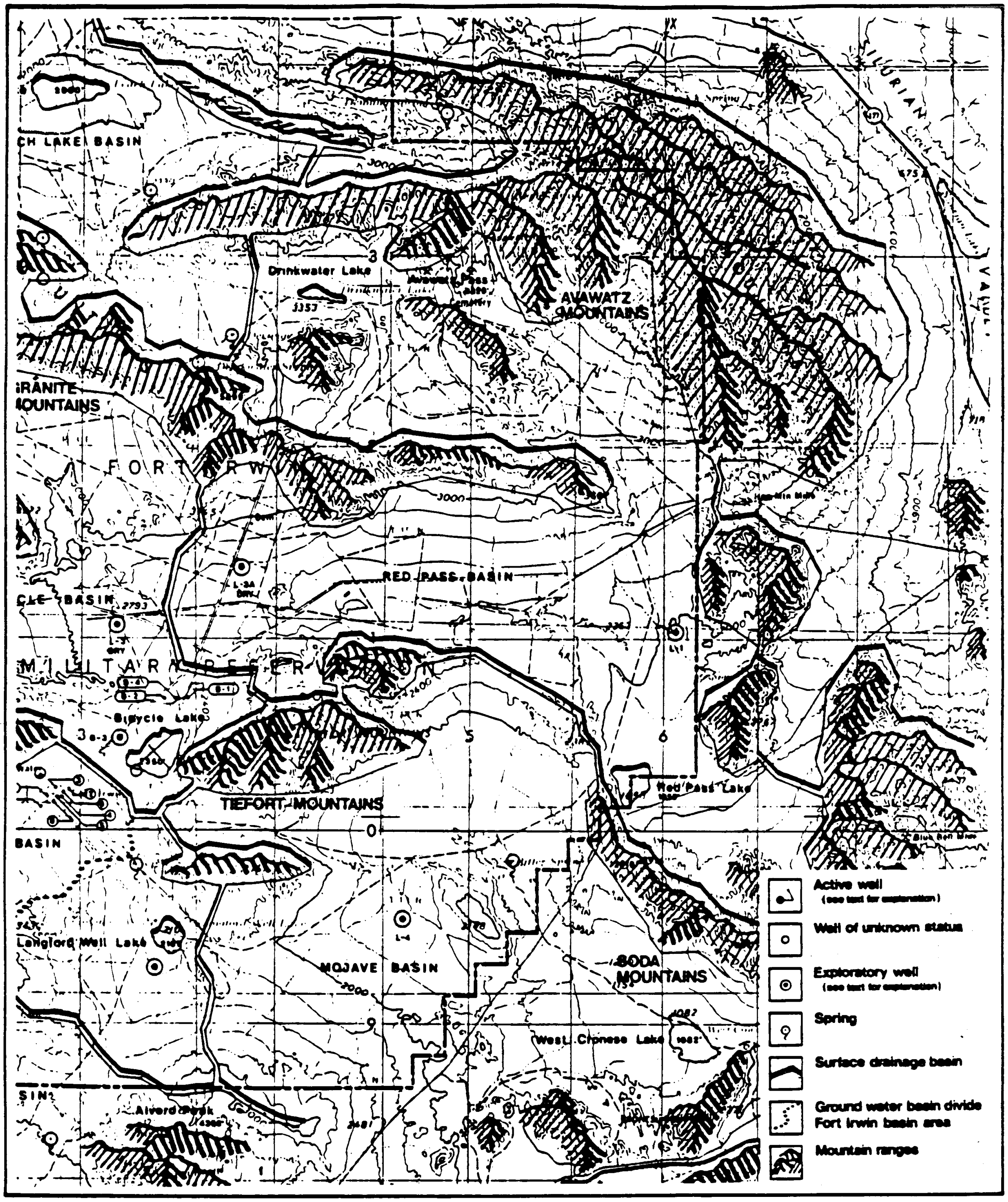
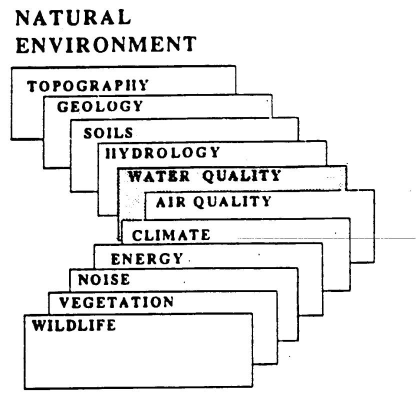


Figure 2-4

Physiography and Hydrology

E. WATER QUALITY



2-21. Definition. Water quality data is presented in terms of the relative purity of surface and ground water as compared to natural conditions. The Federal Water Pollution Control Act, also called the Clean Water Act, sets forth water quality goals, a permit system, and a regional planning process for assuring the cleanup of the nation's waters. The Safe Drinking Water Act assures the provision of safe sources of water supply. Federal facilities must. meet applicable federal, state, interstate, and local regulations designed to assure compliance with the Clean Water Act and Safe Drinking Water Act, although - exemptions for military-unique situations may be requested from the Environmental Protection Agency. The primary water quality factors to consider in the planning process are federal water quality goals, areawide water quality management plans, and measures of water pollution.

2-22. Data Application.

a. Most water quality issues are -addressed at the installation level. The new activities planned will determine whether there are increases in point and non-point source pollution requiring compliance with National Pollution-Discharge Elimination System (NPDES) permit requirements or state and local non-point source pollution control regulations. Compliance with the Safe Drinking Water Act may be required if the installation provides its own source of drinking water.

b. From a regional standpoint, cooperation with local government may be needed if local government provides drinking water and wastewater treatment. Regional authorities may have enacted drinking water and wastewater standards. Continuous participation in regional planning programs by installation personnel will ensure that installation interests are accounted for and will demonstrate the installation's willingness to address such regional problems as non-point source pollution.

2-23. Relationship to Other Data. Soils information is needed in order to design septic systems, solid waste disposal sites, and spill containment programs. Climatological information, particularly rainfall data can be used to determine the relative importance of non-point source pollution. Geological data can identify the presence of any local aquifers and possible avenues for groundwater contamination such as faults and porous soils and rocks.

2-24. Data Display Alternatives.

- Tables of existing water quality, including runoff and/or well yield
- Tables of point source pollution data (Figure 2-3)
- Tables of surface and subsurface water pollution data

2-25. Data Sources,

a. Federal:

- Water Resources Division, U.S. Geological Survey (see Hydrology)
- Soil Conservation Service (see Soils)
    - Water resources studies
    - Water resources data on state basis

b. State:

- Office of Water Resources, Water Survey Division
- Department of Natural Resources
- Department of Environmental Regulation
  - Water resources studies
  - Water resources data-on county basis
  - Water quality management plans
  - Maps of aquifer locations, water use and quality

c. Regional:

- Regional Planning Agency
- Council of Governments
  - Water supply data
  - Water resources studies
  - Water quality management plan

d. Additional Sources:

- Local Utilities District/Commission
- Installation Environmental Division

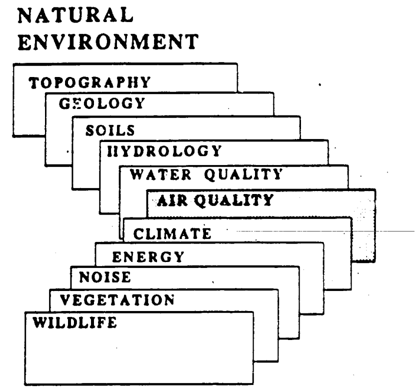
Current Water Quality Problems and Concerns by Zone

River Segment	1A, 1B	1C	1D	1E	2	3	4	5	6
No Problems									
Raw Sewage Discharge	X		X						
Unknown Impacts Due to Increased Recreational Use	X	X							
Occassional Low Dissolved Oxygen				X	X				X
Chronic Dissolved Oxygen Violations						X	X	X	
Occasional Fecal Coliform Violations (seasonal)		X		X	X				X
Industrial Spills						X	X	X	
Combined Sewer Outfalls					X	X	X	X	
Potential for Toxic Materials						X	X	X	
High Benthic Oxygen Demand						X	X	X	
Urban/Industrial Runoff Problem					X	X	X	X	
Non-Point Source Problem					X	X	X	X	X
Massive Amounts of Treated and Inadequately Treated Wastewater						X	X	X	

Figure 2-5

Water Quality

F. AIR QUALITY



2-26. Definition. The quality of the air is affected by many sources and therefore cooperative efforts arc required to ensure that air pollution is maintained at or below an acceptable level. Air quality is defined as the relative purity of ambient air as compared to natural conditions. The Clean Air Act and implementing regulations set forth air quality standards and the mechanisms for obtaining these standards. Federal facilities must meet applicable federal, state, interstate, and local regulations designed to assure compliance with the Clean Air Act, though exemptions for military-unique situations may bed requested from the Environmental Protection Agency. Primary air quality factors to be considered in the planning process are federal air quality goals, state implementation plans, and sources of air pollution.

2-27. Data Application.

a. Required permits for stationary sources and potential requirements to offset emissions are most relevant at the installation comprehensive plan level. Measures to reduce installation traffic problems that lead to air pollution must also be dealt with at this level.

b. Air quality impacts extend beyond the installation planning level to the regional level. Installations can be in one or more air quality control regions (AQCR) which maintain air quality data. The installation must know the attainment status of the AQCR for possible implications for construction of new facilities as well as air pollution emergency plans. Cooperation between all pollution sources in a region is required to attain ambient air quality standards. In addition, participation in vehicle inspection maintenance programs, fuel-vapor recovery programs, transportation control strategies, and emission reduction will often require coordination with other pollution emitters, as well as with EPA, state and local authorities.

2-28. Relationship to Other Data. Information on clean fuel availability is needed to assure compliance with air quality emissions standards for fuel-burning facilities. Data on traffic levels are important for the design of needed transportation control strategies. Climatological factors must be considered in the siting and design of facilities. Areas where inversions are common may be particularly troublesome when new facilities are proposed.

2-29. Data Display Alternatives.

- Tables of air pollution levels (Figure 2-6)
- Maps/plans of air pollution levels

2-30. Data Sources.

a. State:

- Pollution Control Board/Department
- Department of Natural Resources
- Environmental Management/Protection Agency
  - Annual air quality reports
  - Air quality regulations/standards
  - State air quality data
- Air Quality Control Region

b. Regional:

- Regional Planning Agency
- Council of Governments
  - Air quality component of regional land use plan
  - Air Quality Implementation Plan

c. County/Local:

- Department of Environmental Control or Management
    - Annual air quality reports
    - County air quality data
    - County air quality standards
    - Air pollution emergency plans

d. Additional Sources:

- Environmental Protection Agency, Regional Office, Office of Air Quality Planning and Standards
- Utilities Commission/Authority
- Installation Environmental Division

NATIONAL/STATE AIR QUALITY STANDARDS AND FORT STEWART MEASURES

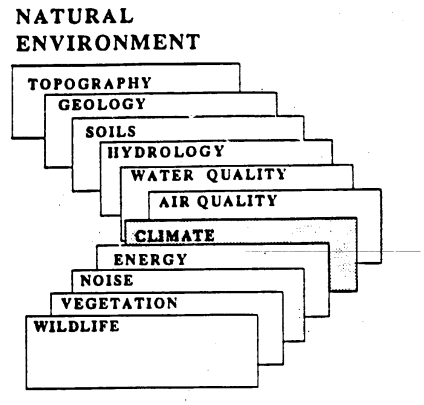
Parts per Million

POLLUTANT	NATIONAL PRIMARY	NATIONAL SECONDARY	GEORGIA PRIMARY	FORT STEWART 1975	FORT STEWART 1977	FORT STEWART 1979
Particulate Matter:						
Annual Geometric Mean	75	60	60	49.86	44.7	38.8
Sulfur Oxides:						
Annual Geometric Mean	80	60	43	4.04	11.3	17.1
Nitrogen Oxides:						
Annual Geometric Mean	100	100	-	21.12	27.8	26.2
Carbon Monoxide: Maximum 8-Hour Concentration	10,000	10,000	10,400	N/A	N/A	N/A
Maximum 1-Hour Concentration	40,000	40,000	40,000	N/A	N/A	N/A
Hydrocarbons: Maximum 3-Hour Concentration	160	160	-	N/A	N/A	N/A

Figure 2-6

Air Quality

G. CLIMATE



2-31. Definition. Climate influences comprehensive planning by shaping the landscape on a regional scale and by influencing site-level decisions on facility location, orientation, and construction. Climatic information is particularly useful in planning for energy efficiency. Climate is defined as the average course or conditions of the weather at a place over a period of years as exhibited by temperature, wind velocity, and precipitation. Climate can have a great effect upon planning opportunities and constraints; for example, at northern-tier installations snow removal and emergency snow routes are primary considerations in comprehensive planning. Primary climatic planning factors to recognize are air temperature, radiation, wind, precipitation, humidity, microclimate, and comfort.

2-32. Data Application.

a. Planners can use climatic data at the installation comprehensive planning level, but the data are usually regional in scope and therefore must be site-applied. Temperature and precipitation data can generally be applied directly to on-site energy-conscious planning, but site microclimatic characteristics may alter the general data. Site microclimate will be unique due to local topography, slope orientation, water features, built structures and other landscape elements.

b. Climate has historically affected the patterns of community development. With the advent of mechanical heating and air conditioning, new architectural structures have been able to be built without regard to climate zones; however, the energy demands required to run such structures are usually greater than those required for buildings designed with climate in mind. Planners should use site-specific and installation layouts and generic architectural designs that are responsive to the dynamics and characteristics of regional climates (usually recorded for regions and subregions from airport and city-center locations). Such sensitivity in site location planning, and design will result in a more cost-effective, livable installation.

c. Temperature and humidity are directly related to the effectiveness of mechanical cooling systems. Extreme and rapid changes in weather affect the curing time of concrete, the productivity and safety of workers, and the transportation of goods. The depth of freezing has a strong effect on all forms on construction.

2-33. Relationship to Other Data.

a. Climate has a strong relationship to all of the other natural and cultural processes. It controls the life cycles of animals and plants and the land use (especially agricultural) practices of man. Climate also affects the character of stream flow and the amount of ground water available.

b. Climate can be conducive to or inhibit outdoor recreation and operational/training activities. Topographic and vegetative features can create microclimatic zones on a site (e.g., slope orientation; hills and treelines that act as windbreaks; valleys that "collect" cool air). Climate has traditionally influenced the location of human settlements, making some areas more likely to contain archaeological or historic sites than others.

2-34. Data Display Alternatives.

- Sun orientation charts; azimuth and altitude angles
- Wind orientation charts
- Annual and daily temperature charts
- Microclimate studies (Figure 2-7)

2-35. Data Sources.

a. Federal:

- National Climate Center, NOAA, U.S. Department of Commerce
  - Local climatological data
  - Tidal data
  - Hourly precipitation data
  - Snow cover survey, storm data
- National Weather Service
- Federal Aviation Administration

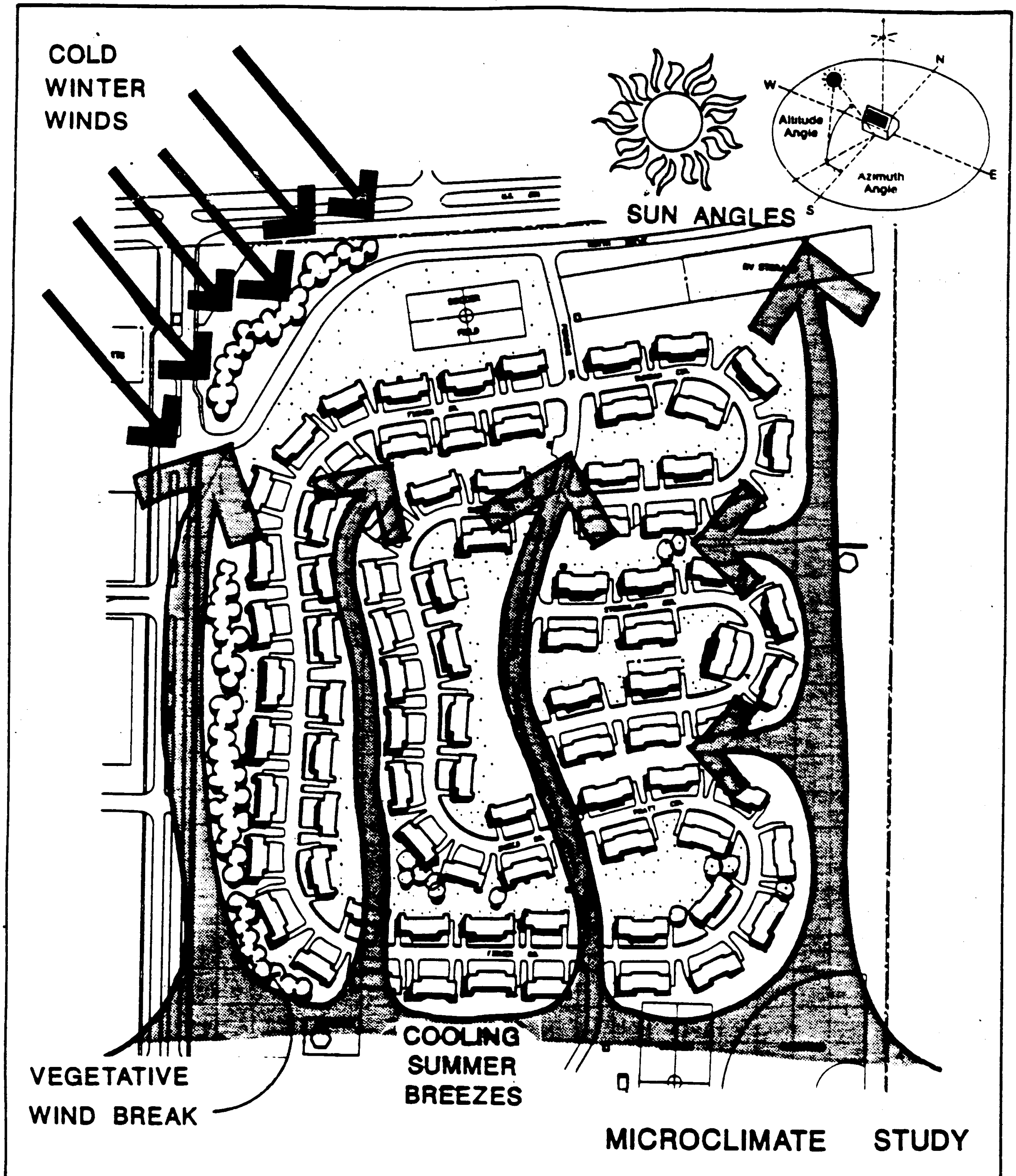
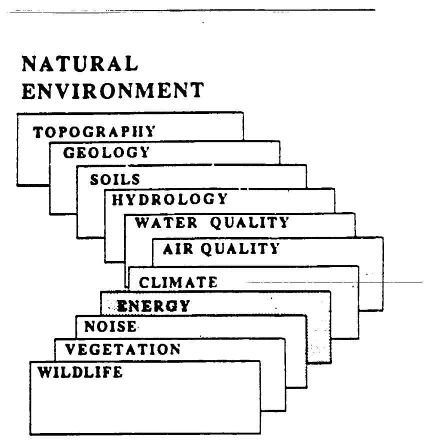


Figure 2-7

Climatological Data

H. ENERGY



2-36. Definition. Energy resources allow the installation to perform its mission. A goal of each installation is to conserve energy resources. Energy resource conservation can contribute to flexibility and innovation in site planning and architectural design. Energy conservation planning considers the factors of climate/microclimate, solar orientation, shade and wind, circulation patterns, and land use patterns.

2-37. Data Application.

a. Energy efficiency can be considered at many levels, but the most control can be exercised at the installation planning and site design levels. Installation energy planning embraces solar orientation of structures to maximize energy efficiency; compact building clusters to reduce the number and length of auto trips; inclusion of pedestrian/bicycle systems and transit service on site and to off-site services; perimeter parking lots with pedestrian/bus links to on-site locations; protection of an individual building's solar access; maximum use of east-west streets to allow for efficient building solar orientation; a more flexible attitude and approach to building siting for energy conservation; the increased use of active and passive solar energy systems (more effective use of awnings, overhangs and other shading devices); and the use of energy-conscious landscape planting/preservation techniques.

b. Many of the energy-based techniques applicable on a site-specific basis can be employed in planning for large areas. The relationship of housing locations to the workplace, the price of fuel, general climatic effects, mass transit availability and major power/heat sources arc all important at this scale and at the regional scale.

Development of generic site and architectural criteria could ensure more consistent energy-efficient project development and result in major energy cost savings. In addition, coordination of energy planning goals, objectives and approaches with local and regional governments is important to the success of regional planning efforts.

2-38. Relationship to Other Data.

a. Energy-based planning uses data from several categories, primarily climatic, topographic and vegetative; this data can be used in planning for active and passive solar energy systems and in siting structures in the landscape to minimize energy loss and maximize gain when desired. Surface hydrologic features such as lakes, rivers, streams and waterfalls could be sources of hydroelectric power. Geologic thermal features could be utilized as power/steam heating sources in certain instances.

b. Land use, transportation and utility planning approaches can have an effect on an installation's energy consumption. Compact land use clusters and mixed-use development cores can reduce fuel costs by reducing auto trips and require less linear footage of utility systems and roads; however, military operational and safety constraints may restrict the opportunities for clustering activity uses efficiently.

2-39. Data Display Alternatives.

- Energy consumption models

2-40. Data Sources.

a. State:

- Division of Energy, Department of Commerce or Statistical Department
  - State energy consumption reports (Figure 2-8)
  - Forecasts of statewide energy use
  - State energy model
  - Energy statistics

b. Regional:

- Regional Planning Agency
- Council of Governments
  - Regional land use plan, energy and transportation components
  - Regional energy use plan
  - Regional transportation plan
  - Existing and forecast energy consumption rates

c. Additional Sources:

- Local Planning Department
- City Public Works Office
- U.S. Department of Energy

RENEWABLE RESOURCE PLAN IMPACT*
Direct Energy
BTU's

	1986	1991	1996
Passive Solar	0.3	0.8	1.5
Active Solar	0.1	0.3	0.5
Wood	1.5	4.3	7.1
BioGas	3.5	3.1	5.7
Resource Recovery	1.1	5.2	4.2

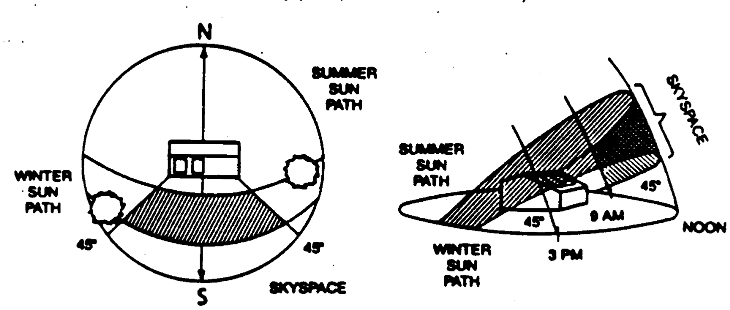
* Numbers shown represent reduction in end use energy requirements.
Source 1

RENEWABLE RESOURCE PLAN IMPACT*
Electricity Generation
(MW)

	1986	1991	1996
Small Hydro	0	27	325
Cogeneration	208	412	600
Resource Recovery	50	63	82
Wind	12	82	307

* Numbers shown represent additions over the capacity projected
Source 1

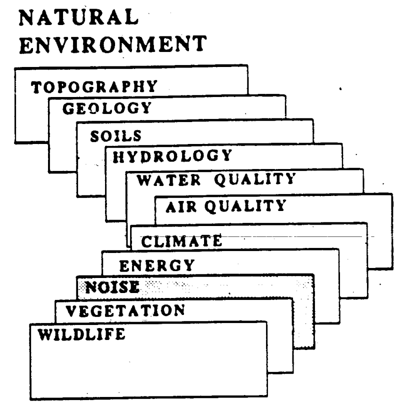
Solar Skyspace (Plan and Isometric Views)



Source 2

Figure 2-8
Energy Data

I. NOISE



2-41. Definition. Noise is defined as unwanted sound, sound that interferes with hearing, communication, or activities. It is important for the planner to consider sources of noise and ensure chat the health and welfare of the varied recipients of noise, including installation personnel and residents and users of land surrounding the installation, are protected from the adverse impacts of high level noise. Standards for protecting the public health and welfare have been developed in response to the Noise Control Act of 1972 (P.L. 92-574) and the Occupational Health and Safety Act of 1970 (P.L. 91-596) and are presented in AFM 19-10 (Air Force) and TM 5-803-2 (Army). The planner must determine the extent of the military's role in preventing conflicts between people and noise and prepare the comprehensive plan so as to reduce the conflicts through direct elimination or mitigation or through cooperative efforts with outside receivers. Noise impacts on receivers both on and off the installation should be mitigated. The primary noise factors to consider are noise sources, noise receivers, vibration sources, measurements of noise, and assessment of noise levels.

2-42. Data Application.

a. Noise impact aspects of planning are usually considered at the installation level. Noise conflicts generated from within the installation should be resolved through proper land use relationships, structural/construction methods, and landscape design. Noise conflicts originating outside and affecting the installation should be addressed specifically at this level. Noise impacts on any receiver should be mitigated to comply with federal standards.

b. Noise impacts transcend the installation comprehensive plan level and affect the vicinity and regional scale of planning. Usually, however, noise impacts can be directly tied to specific sources so that some form of mitigation can be applied. The Air Installation Compatible Use Zone/Installation Compatible Use Zone (AICUZ/ICUZ) Program is intended to address regional and vicinity level noise issues as they relate to military air installations. The key-mitigation factor employed in AICUZ/ICUZ programs is land use control in high noise impact zones. A high degree of coordination is required between military and local/regional civilian planners to address major AICUZ/ICUZ issues properly. (AICUZ/ICUZ also addresses accident potential as well as noise impacts.)

2-43. Relationship to Other Data. Data on transportation plans, land use plans, vegetation and topography both on the installation and in the adjacent community are needed to assess the significance of noise impacts. Data on transportation are needed to determine noise sources and estimate existing and projected noise levels associated with vehicular traffic. Information on existing and planned land uses is needed to identify other possible noise sources and to determine whether noise-sensitive land uses are present and may be affected by high noise levels. Information on topography and vegetation is needed to assess whether the natural land form and its cover act to screen or partially screen the noise source from receivers.

2-44. Data Display Alternaives.

- Noise contour mapping (Figure 2-9)
- Table of point source noise level

2-45. Data Sources.

a. State:

- Department of Environmental Regulation Protection
- Department of Health, Noise Pollution Control Office
- Department of Transportation
  - Noise contours for airports
  - Noise regulations
  - Noise data
  - Aeronautical charts

b. Regional:

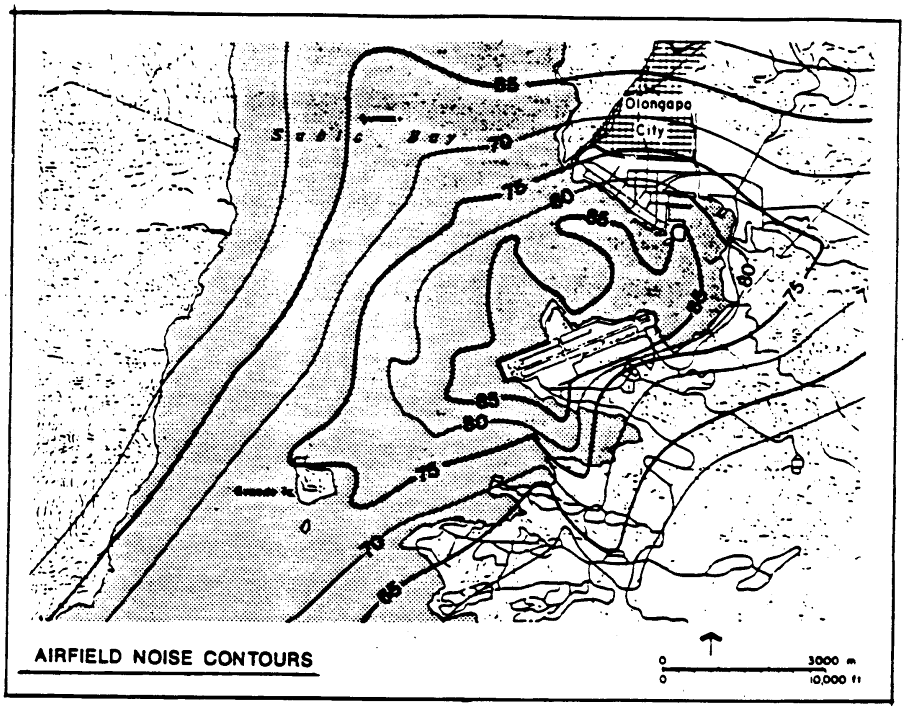
- Regional Planning Agency
- Council of Governments
  - Noise components, regional land use plan
  - Noise models
  - Airport systems plans, master plans
  - Noise management studies

c. Military:

- Installation Environmental Division
  - AICUZ/ICUZ studies and instructions
  - Noise data
  - Aeronautical charts
  - On-site testing

d. Additional Sources:

- Environmental Protection Agency
- Local land use plans and zoning ordinances



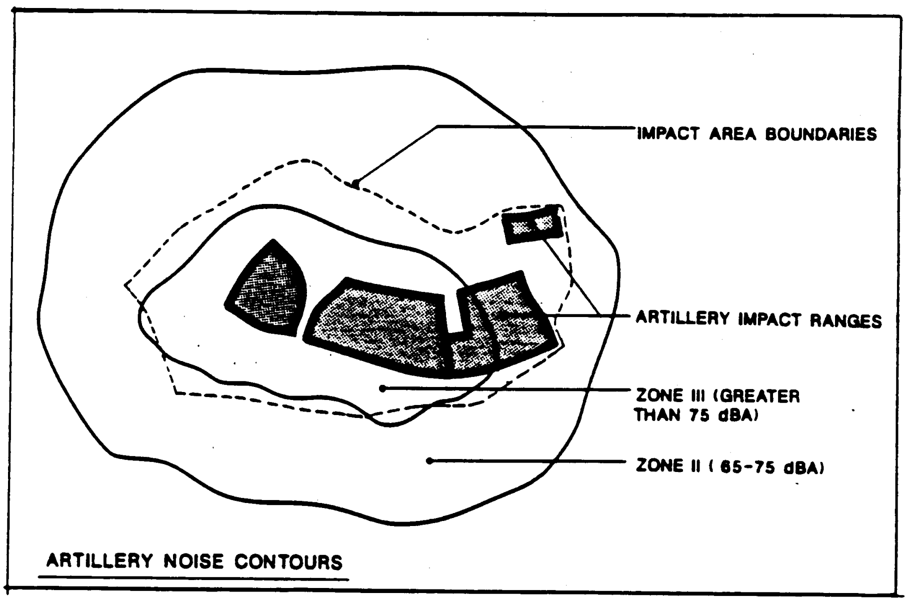
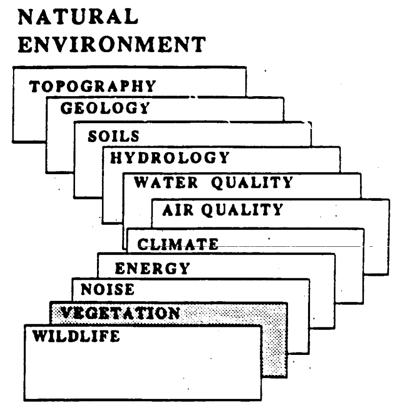


Figure 2-9

Noise Contour Map

J. VEGETATION

2-46. Definition. Vegetation analysis provides an overview of the systems of flora that characterize an area's natural environment. It is used in conjunction with the soils, topography and hydrology analyses to determine land uses and site layouts to identity resource potential and sensitive areas, and to locate training areas. This information helps the planner to identify the areas most suitable for development with minimal environmental impact. Primary vegetation factors are identification. of vegetation types, endangered and threatened plant species, vegetative value in the natural environment, and vegetation in the built environment.



2-47. Data Application.

a. Vegetation data are most directly applied at the site and installation planning levels. Vegetation opportunities and constraints define development patterns on site through the preservation of prime vegetative resources or endangered and threatened plants. Existing vegetation is optimized through the sensitive siting of compatible uses in wooded areas for shading and aesthetic reasons. Vegetation can mitigate extreme microclimates (i.e., it can buffer severe winter winds and help to channel and cool summer breezes in site development).

b. Vegetation information is valuable in many larger scale studies. The economic resource and recreational benefits produced by major woodlands may have a significant bearing on the quality of life and employment aspects of a region. Properly used vegetation can improve the image, microclimate, noise levels, air quality, and many other features of the natural environment at a regional scale, on installations, and on individual sites.

2-48. Relationship to Other Data. A complex group of interacting factors determine vegetation conditions; climate, hydrology, soils and topography each significantly affect and influence vegetation. Plant types and associations growing in a region are determined by the overall climate. The amounts of atmospheric and ground moisture determine successional plant growth and the health of climate plant populations. Plant growth is related to soils; primary succession occurs slowly as soils develop in extreme conditions. The use of native plant species and/or plants adapted to the climate and soils of each region helps to conserve water and soil resources. Soil cover thickness and topographic relief directly affect the amount of vegetation cover. Areas of prime value for agriculture, silviculture, etc. should be reserved, and whenever possible development should occur in alternative locations.

2-49. Data Display Alternatives.

- Vegetation mapping
- Site sections/profiles (Figure 2-10)
- Image processing - vegetation clarification
- Vegetation height maps
- Vegetation density maps
- Vegetation models of natural succession

2-50. Data Sources.

a. Federal:

- U.S. Geological Survey
- U.S. Fish and Wildlife Service
- National Marine Fisheries Service
- USDA Forest Service
- Bureau of Land Management

b. State:

- Department of Conservation
- Natural History Survey
- Game & Fish Commission
- Department of Natural Resources
  - State natural areas inventory
  - Endangered and threatened species list
  - Vegetation cover maps and texts
  - Reports on agricultural/forest resources

c. Regional:

- Regional Planning Agency
- Council of Governments
  - Vegetation component, regional land use plan
  - Vegetative cover maps
  - Reports on agricultural/forest resources

d. Additional Sources:

- Qty/Local Planning Office
- Utilities District/Commission
- Installation Environmental Division

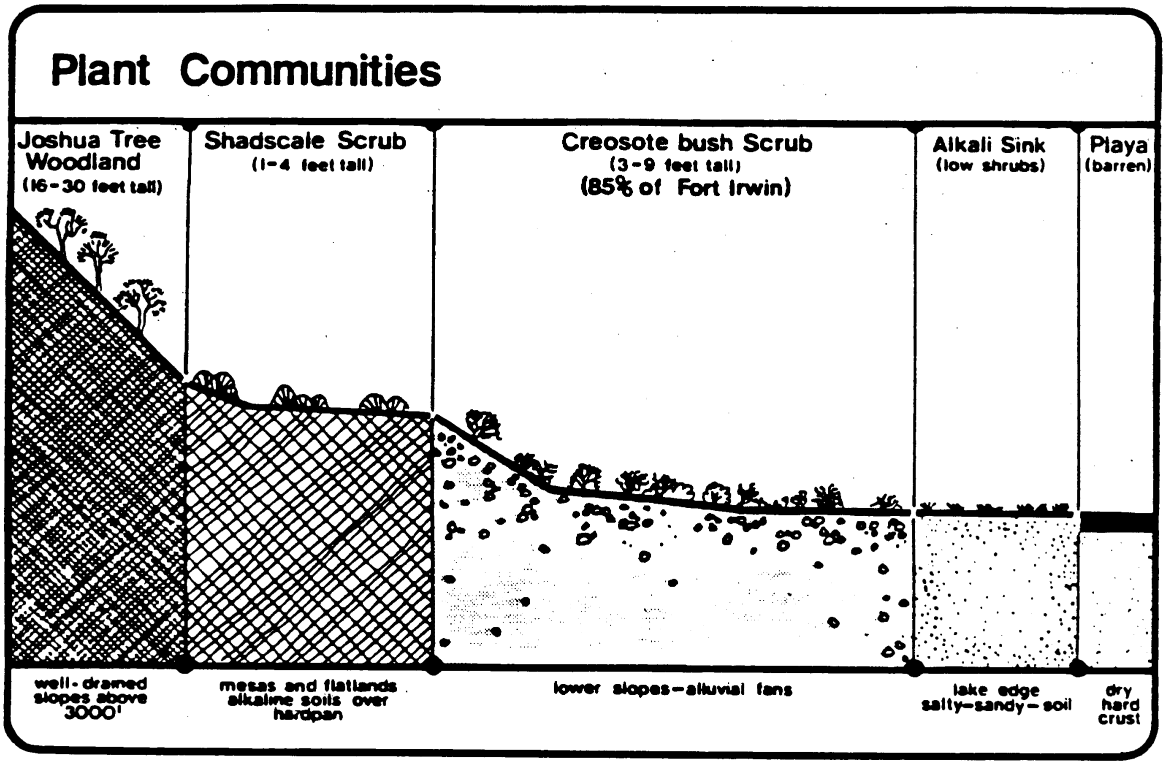
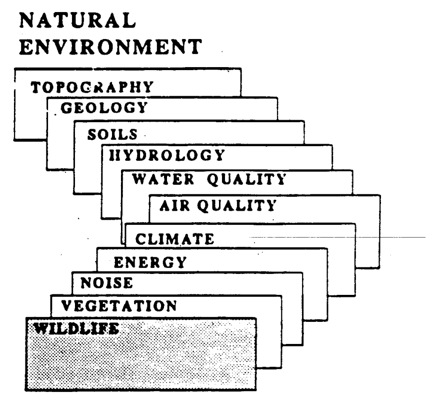


Figure 2-10

Plant Communities

K. WILDLIFE

2-51. Definition. A wildlife analysis, including a discussion of habitat, will enhance the planner's understanding of an area's natural environment. An analysis of the wildlife characteristics and resource potential will help the planner to assess the suitability of an area for wildlife management preservation along with development and construction Primary wildlife planning factors arc identification of wildlife types, including endangered and threatened species, and habitat/wildlife management.



2-52. Data Application.

a. The study of wildlife and wildlife habitat is relevant at the installation and site scale. Potential recreation benefits of wildlife should be considered. - Most of the impacts upon wildlife habitats and effects of wildlife on the operations of the installation occur at the small area level or -at the vicinity scale as it affects a particular cluster of uses.

b. Much of the available wildlife data can be obtained at a regional scale. This scale of information may require additional interpretation to apply and use the data at an installation and site scale. It should be noted that such regional data can be applied only generally at a site-specific level; detailed installation data can be obtained only by on- site wildlife surveys.

2-53. Relationship to Other Data. A strong relationship exists between soil type, the kinds of vegetation the various soil types will support and the distribution of animals within the protective cover. For example, at a site located between coniferous forests and deciduous forests, the wildlife species present may be characteristic of both vegetative types. Climate and hydrology also affect vegetation species and distribution, since both greatly influence the habitat characteristics. Land use types of various intensities can act as deterrents or attractors to different wildlife species. Proper analysis and management of wildlife benefit both the natural environment and the quality of built environments at all scales.

2-54. Data Display Alternatives.

- Wildlife habitat area and migration corridor mapping (Figure 2-11)
- Endangered species habitat mapping
- Wildlife habitat models
- Wildlife population maps

2-55. Data Sources.

a. Federal:

- U.S. Fish and Wildlife Service
- National Marine Fisheries Service
- Soil Conservation Service (see Soils)
- U.S. Geological Survey (see Geology)
  - State inventories
  - State/national endangered and threatened species lists
  - Vegetative cover maps (U.S.G.S.)

b. State:

- Department of Conservation
- Natural History Survey
- Game & Fish Commission

- Department of Natural Resources
    - State natural areas inventory
    - Endangered and threatened species lists
    - Wildlife/biological inventories
    - Wildlife habitat areas

c. Regional:

- Regional Planning Agency
- Council of Governments
    - Wildlife section, regional land use plan
    - Wildlife habitat areas

d. Additional Sources:

- City/Local Planning Office

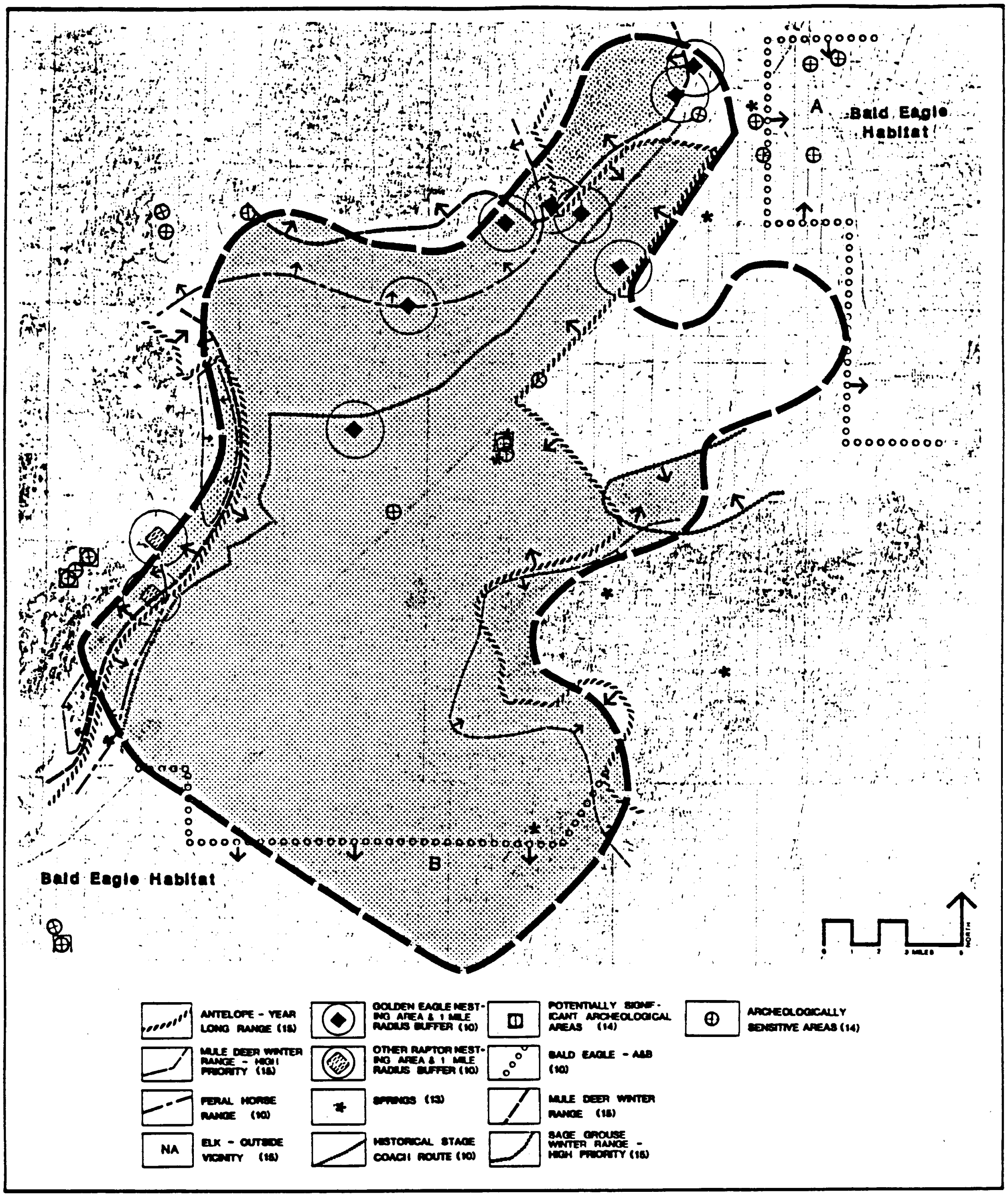


Figure 2-11

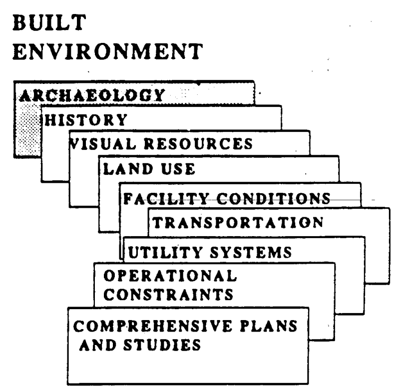
Wildlife Mapping

CHAPTER 3. THE BUILT ENVIRONMENT

Chapter 3

The Built Environment

A. ARCHAEOLOGY



3-1. Definition. The National Historic Preservation Act of 1966, as amended in 1980, mandates that each federal agency shall locate and inventory all resources of archaeological, cultural, historic, architectural, and engineering significance on federal properties or under federal management. Archaeological resources are the material remains (fossil relics, artifacts, and monuments) of past human life and activities. Guidelines for their protection are included in the Archaeological Resources Protection Act of 1979. (Air Force regulation 126-7 and Army regulation 420-40, both titled Historic Preservation, outline procedures for identifying and preserving archaeological resources.) Primary archaeological factors to be considered in the planning process are artifacts, dating, surveys, and evaluations.

3-2. Data Application.

a. The archaeological survey identifies sites of archaeological value and provides an analysis of prehistoric and historic human activities as well as an evaluation of archaeological resources. It is used, along with the historic survey, to provide information on the earlier use of a site and to identify resource potential and sensitive areas that may affect current and future Land use. Such documentation is useful to the planner as it identifies, categorizes, and evaluates cultural resources requiring protection as well as sites least suitable for construction due to impacts on cultural resources. Careful identification and evaluation of resources enables the planner to make recommendations for future cultural resources management.

b. Installation commanders are required to locate and inventory on-site archaeological resources in accordance with the National Historic Preservation Act of 1966, amended in 1980. Detailed mapping and descriptions of archaeological surveys will determine eligibility of the site for listing on the National Register of Historic Places.

3-3. Relationship to Other Data.

a. Climate, soils, vegetation, wildlife and hydrology all affect and relate to archaeological resources. Archaeological sites are likely to be found in areas where the requirements for successful agriculture were present because of a beneficial climate or where exploitation of specific resources (food plants, game animal) could occur following seasonal changes.

b. Prehistoric settlement location was typically based on the availability of raw materials, freshwater sources and exploitation of natural resources. Soil types, the vegetation they can support and the distribution of animals within the vegetative cover are closely related. Archaeological sites are most frequently located in highly fertile areas with soils favorable to agriculture. In some areas, there is a direct correlation between animal grazing and hunting activities and archaeological sites. Archaeological resources also relate to hydrology; fishing and travel by water are two reasons why prehistoric man lived next to or close to water bodies. Archaeological resources are frequently located near lakes, rivers or stream beds.

3-4. Data Display Alternatives.

- Archaeological site locations (Figure 3.1)
- Potential cultural resource location
- Cultural resource data base

3-5. Data Sources.

a. Federal:

- National Park Service
- Secretary of the Interior

b. State:

- State Historic Preservation Officer
- Department of Cultural Resources
- Department of Natural Resources
- State Archaeological Survey
- Division of Archives and History
- Historic Sites Division
- University departments of archaeology or anthropology

c. Regional:

- Regional Planning Agency
- Council of Governments
  - Archaeological component, Land use plan (local/city scale)
  - Archaeological survey, inventory (regional scale)
- Native American governments
- Native American religious leaders (Shamans and Medical Men)

d. County/Local:

- County Planning Office
- City/Local Planning Department
  - Archaeological component, Land use plan
  - Archaeological survey, inventory
  - Historic records

e. Additional Sources:

- Installation Environmental Division
  - Archaeological component, installation comprehensive plan and AICUZ/ICUZ (base scale)
  - Archaeological and historical survey, inventory
  - Historic military records
  - Predictive studies
  - Fieldwork surveys

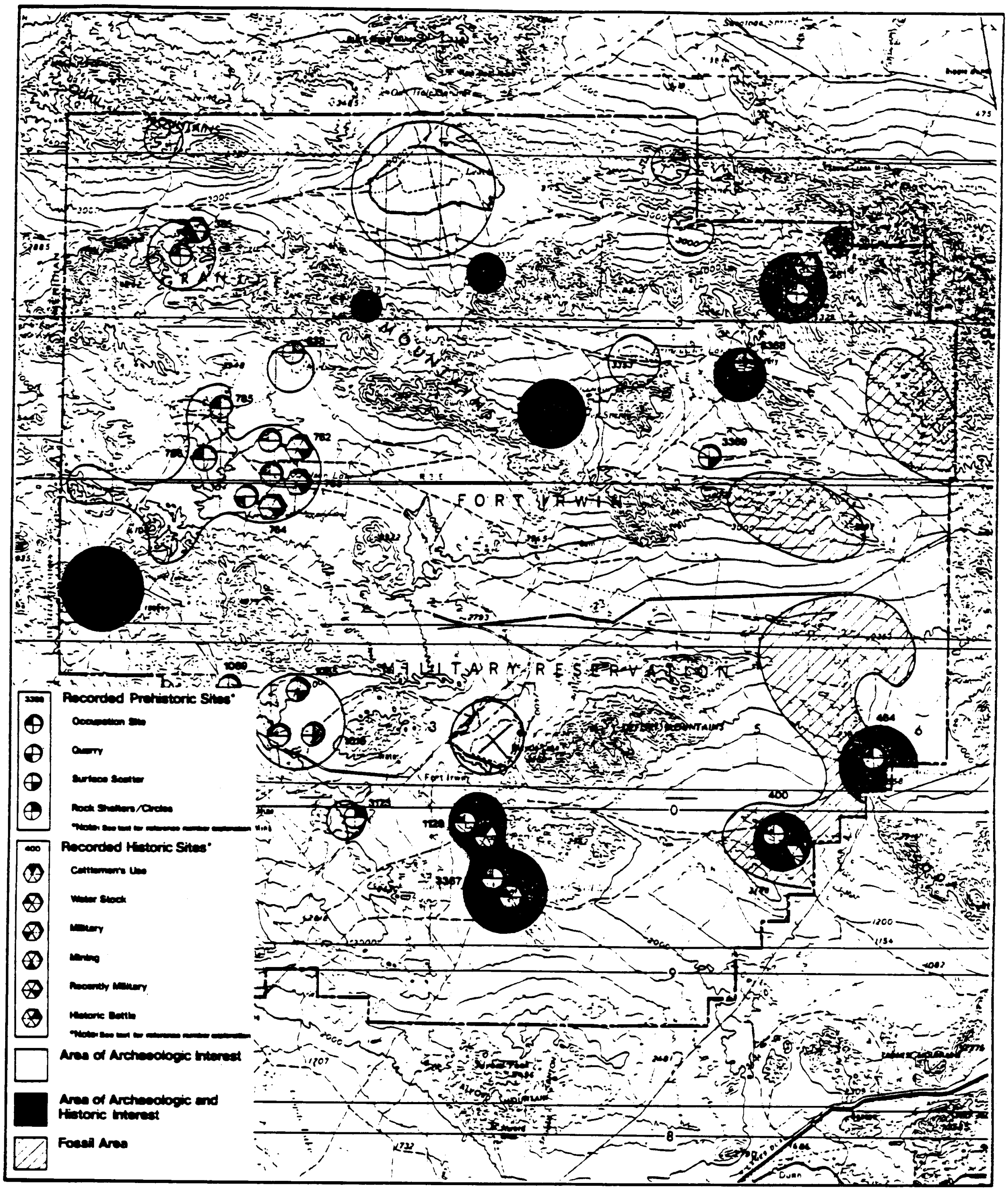
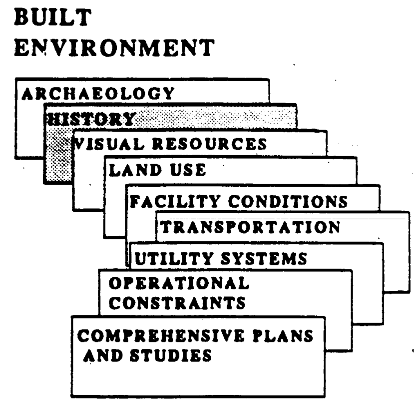


Figure 3-1

Archaeological & Historic Resources

B. HISTORY

3-6. Definition.



a. Section 106 of the National Historic Preservation Act of 1966 mandates consultation with the Advisory Council on Historic Preservation on any actions affecting historic resources. Historic. surveys will determine eligibility for listing on the National Register of Historic Places and protection status of the site or structures. Detailed mapping and descriptions of historic sites and structures will provide opportunity to integrate compatible new development into an existing historic fabric. In turn, these valued resources can form the cultural and visual focus of an installation. The primary historic resources planning factors are identification of resources, dating, surveys, and evaluations. (Air Force regulation 126-7 and Army regulation 42()AO, both titled Historic Preservation outline procedures for identifying and preserving historic resources.)

3-7. Data Application.

a. The historic resources survey provides the plannerwith an analysis of earlier, documented activity on a site and areas adjacent to a site. It is used, along with the archaeological survey, to identity cultural resource potential; to describe sensitive historic structures and areas that may affect Land use; and to guide building siting in the plan. Identification of historic resources enables the planner to make recommendations for future cultural resource management as well as minimize the impact of construction on historic resources.

3-8. Relationship to Other Data. Historic information relates strongly to archaeologic settlement patterns and all past aspects of urbanization (for example, transportation and Land use patterns). The natural conditions of sites are instrumental in historic resource location and study. Climate influenced human settlement patterns, and ocean and riverine edges provided sites for development historically.

3-9. Data Display Alternatives.

- Historic site location
- National Register of Historic Places nomination forms (Figure 3-2)
- Historic district mapping
- Historic building survey data base

3-10. Data Sources.

a. Federal:

- National Park Service

b. State:

- Department of Cultural Resources
- State Historic Preservation Office
- Department of Natural Resources
- State Archaeological Survey

c. Regional:

- Regional Planning Agency
- Council of Governments
  - Historical component, Land use plan
  - Historical survey, inventory (regional scale)

d. Local/City:

- Planning Department
  - Historical component, Land use plan
  - Historical survey, inventory
  - Historic records

e. Additional Sources:

- Installation Environmental Division
  - Historical component, installation comprehensive plan and AICUZ
  - Fieldwork survey, inventory of installation
  - Historic military records
- County Planning Office

Form No. 10-300 (Rev 10-74)

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

NATIONAL REGISTER OF HISTORIC PLACES INVENTORY -- NOMINATION FORM

FOR NPS USE ONLY
RECEIVED
DATE ENTERED

SEE INSTRUCTIONS IN *HOW TO COMPLETE NATIONAL REGISTER FORMS*
TYPE ALL ENTRIES -- COMPLETE APPLICABLE SECTIONS

1 NAME

HISTORIC: Hangar 9 (Brooks Air Force Base)

AND/OR COMMON: Edward H. White II Museum

2 LOCATION

STREET & NUMBER: Inner Circle Road, Brooks Air Force Base
—NOT FOR PUBLICATION

CITY, TOWN: San Antonio — VICINITY OF
CONGRESSIONAL DISTRICT: 23

STATE: Texas CODE: 48 COUNTY: Bexar CODE: 029

3 CLASSIFICATION

CATEGORY	OWNERSHIP	STATUS	PRESENT USE	
—DISTRICT	X PUBLIC	X OCCUPIED	—AGRICULTURE	X MUSEUM
X BUILDING(S)	—PRIVATE	—UNOCCUPIED	—COMMERCIAL	—PARK
—STRUCTURE	—BOTH	—WORK IN PROGRESS	—EDUCATIONAL	—PRIVATE RESIDENCE
—SITE	PUBLIC ACQUISITION	ACCESSIBLE	—ENTERTAINMENT	—RELIGIOUS
—OBJECT	—IN PROCESS	X YES: RESTRICTED	—GOVERNMENT	—SCIENTIFIC
	—BEING CONSIDERED	—YES: UNRESTRICTED	—INDUSTRIAL	—TRANSPORTATION
		—NO	—MILITARY	—OTHER

4 OWNER OF PROPERTY Contact: Base Commander, Brooks Air Force Base
John Bullard, Base Historian

NAME: U.S. Government; Department of Defense

STREET & NUMBER: The Pentagon

CITY, TOWN: Washington — VICINITY OF STATE: D.C.

5 LOCATION OF LEGAL DESCRIPTION

COURTHOUSE, REGISTRY OF DEEDS, ETC.: Office of the County Clerk

STREET & NUMBER: Bexar County Courthouse

CITY, TOWN: Houston STATE: Texas

6 REPRESENTATION IN EXISTING SURVEYS

TITLE: Texas State Historical Survey; National Register of Historic Places

DATE: 1970; 1970 X FEDERAL X STATE —COUNTY —LOCAL

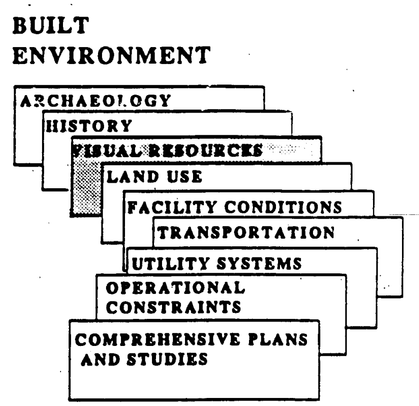
DEPOSITORY FOR SURVEY RECORDS: Texas State Historical Commission; National Register

CITY, TOWN: Austin; Washington STATE: Texas; D.C.

Figure 3-2

National Register of Historic Places Nomination Form

C. VISUAL RESOURCES



3-11. Definition. Visual resources refer to a composition of natural and built surroundings that combine to result in a favorable or unfavorable appearance. Primary visual factors to be recognized in the planning process are types of resources, physical prominence, and value to the installation.

3-12. Data Application.

a. Visual structure is concerned with the qualitative aspects of perception of the environment and how perception creates a sense of place. Visual structure is comprised of elements that establish overall character, including edges, entrances, circulation corridors, activity nodes, orientation elements and visual districts (see Figure 3-3). The identification and evaluation of these elements provides a baseline of information describing appearance and visual character.

b. Visual quality analysis includes an identification -and assessment of those elements, views, sightlines and areas that establish visual character and image and may be sensitive to change. Assessment of visual quality can include identification of positive and negative visual elements, positive and negative views and sightlines, and positive and negative visual character of identified areas or districts (see Figure 3- 3).

c. Analyses of visual conditions can be synthesized into specific recommendations that may include:

- Identification of areas of visual preservation, or those areas of positive visual character that should be maintained;
- Identification of areas for visual renewal, or areas where visual change through Landscape and architectural enhancement are required;

- Identification of visually significant areas which may require application of specific design guidelines; or
- Identification of areas for which the creation of a visual focus is desirable.

Compatibility Guides, Installation Design Guides

3-13. Relationship to Other Data.

a. Visual criteria relate strongly to the visually prominent elements of the natural and built environments on and off an installation. The natural conditions of topography, surface water, and vegetation can positively affect the appearance of an installation. Facility conditions, utilities and infrastructure can present a positive or negative image.

b. Visual resources and their analysis provide direct input to the preparation of guidelines for environmental design, Landscape design and architectural compatibility.

3-14. Data Display Alternatives.

- Photographic surveys
- Visual structure mapping (see Figure 3-3)
- Visual quality mapping (see Figure 3-3)
- Visibility analyses mapping
- Digital terrain models (DIM)
- Computer base 3-D perspective modeling
- Visual impact models
- Photomontage visual simulation

3-15. Data Sources.

- On-site visual surveys
- Previous Planning Assistance Team Studies
- Aerial photographs (vertical and oblique)
- Landscape Development Plans, Architectural

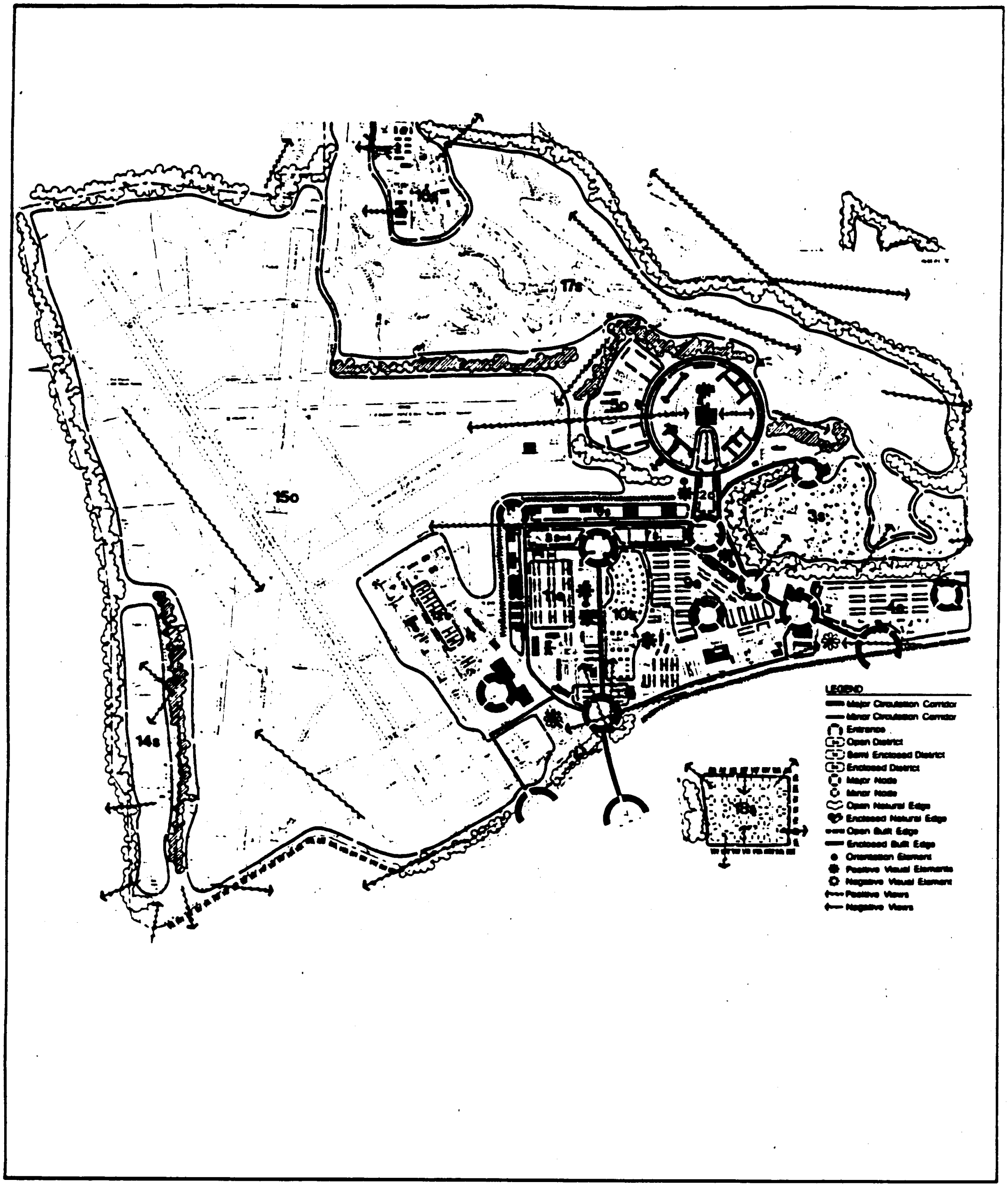
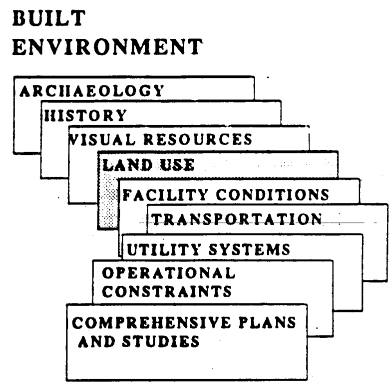


Figure 3-3

Visual Analysis

D. LAND USE



3-16. Definition. The existing Land use analysis is a spatial mapping of the use of all installation Lands according to established Land use categories (refer to Land Use Planning Bulletin/Manual) The future Land use plan provides a framework within which all future facilities are sited. Major considerations in Land use analysis include site and building specific Land use, volume of Land by use, Land use functional relationships, and Land use compatibility.

3-17. Data Application.

a. Land use analysis and data collection and display occur at the installation, vicinity, and regional scale. At the installation scale, the focus is on a parcel-by-parcel documentation to ascertain on-installation Land use conditions as input to the development of a future on- installation Land use plan. Each parcel on the installation should be categorized according to the Land uses described in the Land Use Planning Bulletin/Manual. Land use analysis at the vicinity scale identifies Land use trends and relationships immediately adjacent to the installation which may be mutually influential. For example, the existing of a military community may encourage specific adjacent Land use, while adjacent Land uses can in turn, have visual and operational effects on the military community.

b. At the regional scale the importance of regional Land- use trends, future Land use plans, zoning ordinances and development regulations all may have some relevance to future installation planning. Land use planning at the installation should coordinate closely with local and regional planning boards to be aware of both parties' planning goals and objectives and to encourage mutually beneficial plan development.

3-18. Relationship to Other Data.

a. Land use is affected by both natural and built conditions. Land use patterns are strongly affected by transportation and utility systems, since the availability or lack of these networks can either encourage or discourage development

b. Installation Land use can be affected by existing adjacent area Land use and zoning. For example, Land use intensity increases can create many forms of encroachment threats to military aircraft and weapon testing/training operations, due to increased population densities affected by potential noise and safety impacts of operations. Incompatible Land use can present visual liabilities adjacent to military installation perimeter and entry areas. Security requirements may also present Land use limitations.

3-19. Data Display Alternative

- Existing and future Land use mapping (Figures 3-4 and 3-5)
- Land use allocation models
- Density analysis
- Real property records
- Functional Relationships Models

3-20. Data Sources.

a. Local:

- Regional Planning Agency
- City Planning Department

b. Installation:

- Base layout/general site maps
- Existing and future Land use plans
- Aerial photography
- On-site reconnaissance
- AICUZ/ICUZ plans

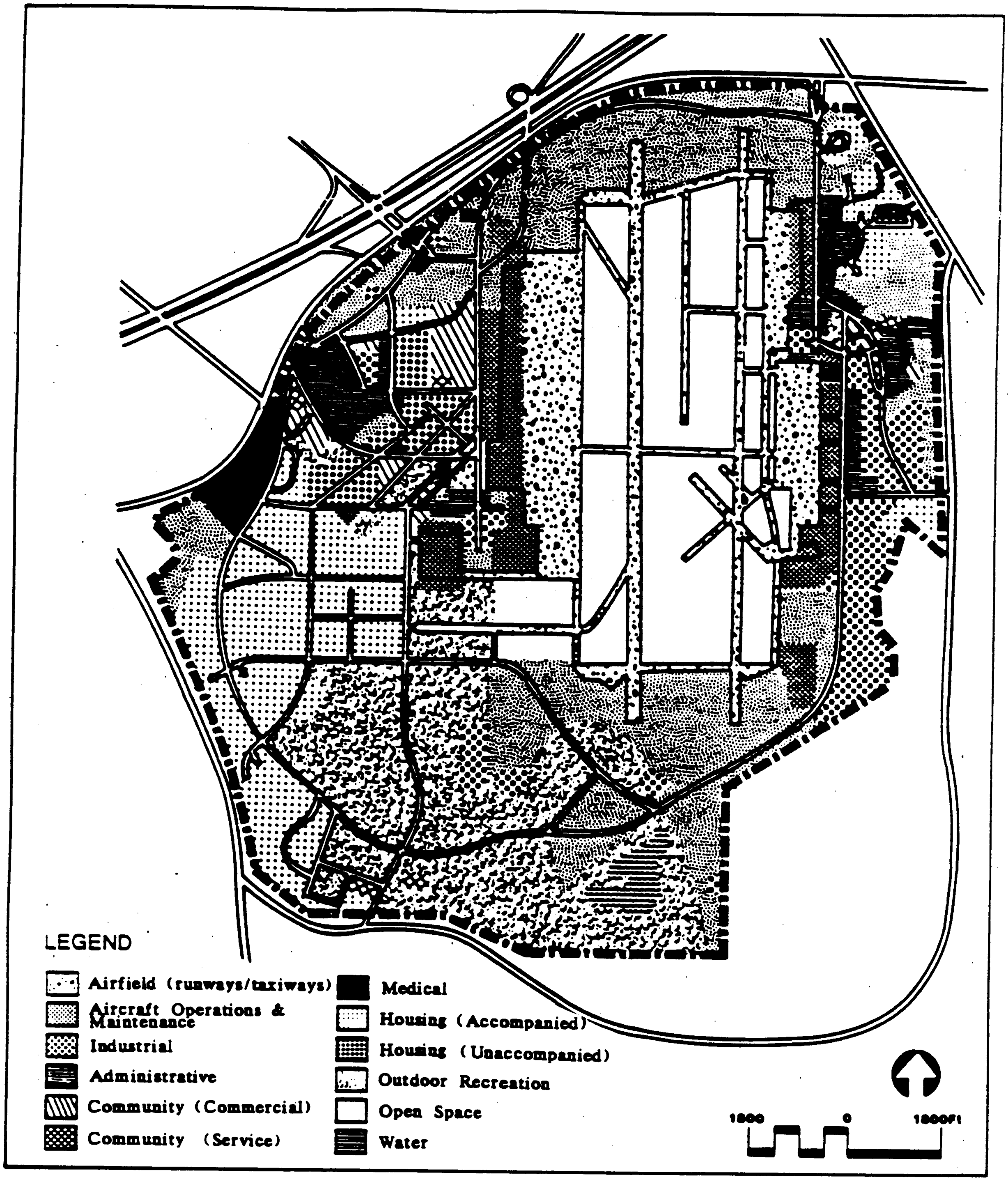


Figure 3-4

Existing Land Use Plan

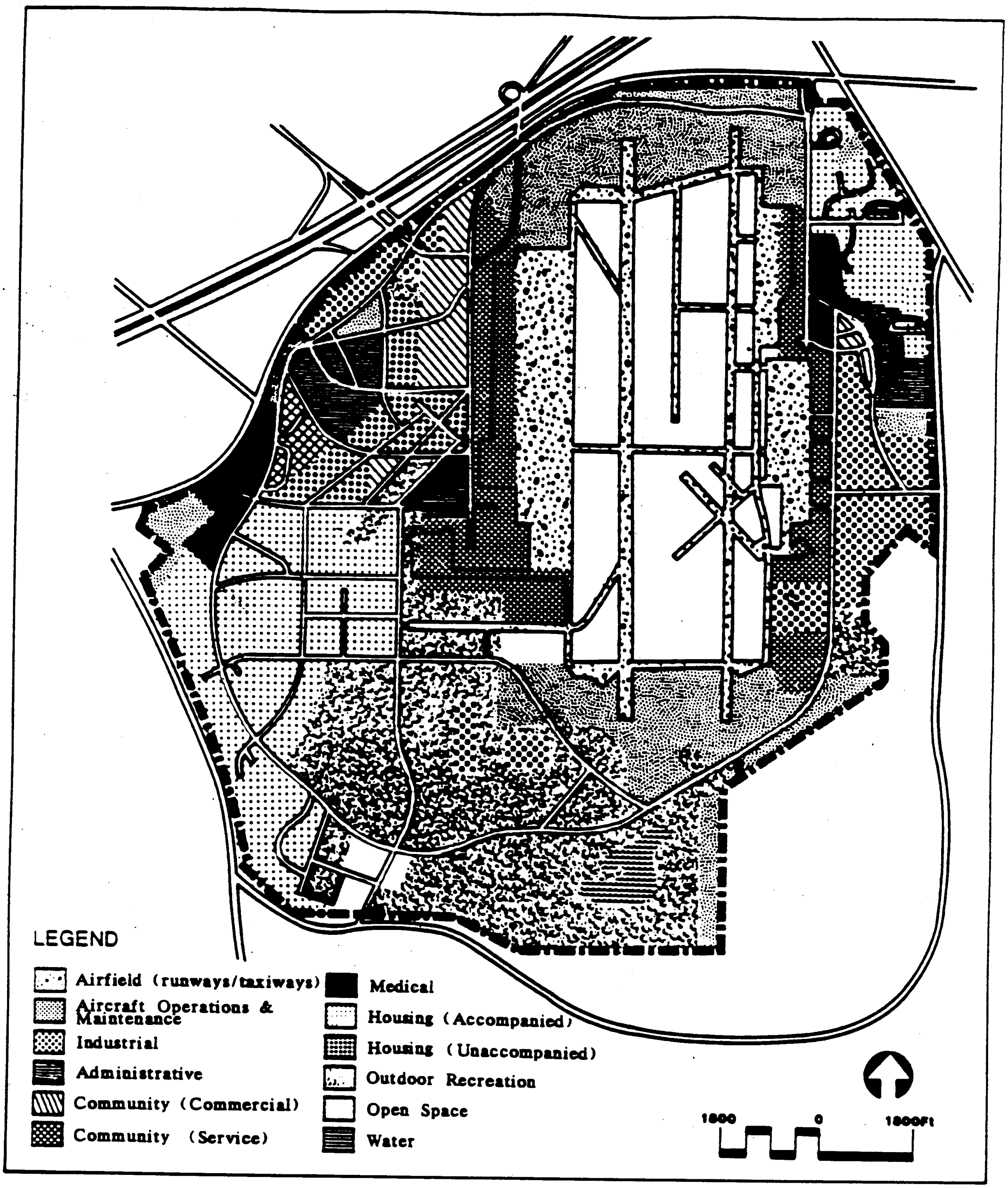
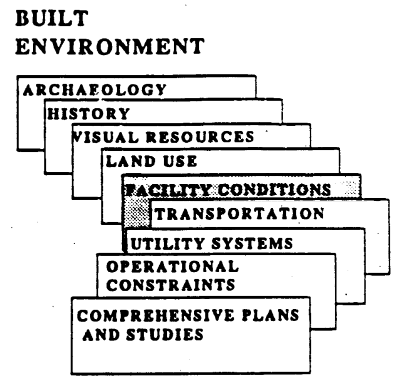


Figure 3-5

Future Land Use Plan

E. FACILITY CONDITIONS



3-21. Definition. Facility conditions describe the state of built elements, structures, and systems at an installation in terms of capacity, readiness, and effectiveness of use toward meeting the stated military mission(s). Primary facility planning elements include facility records, space surveys, and field inventory.

3-22. Data Application. Facility conditions are instrumental in determining the future required facilities. In addition, the facility opportunities and constraints are meshed with the natural opportunities and constraints to produce Land development suitability criteria for use in installation planning.

3-23. Relationship to Other Data. Facility conditions relate directly to transportation, utility and Land use data as key descriptive elements of the built environment. Natural site conditions (hydrology, topography, geology, soils, climate) can affect the location and the structural condition of on-site facilities Military missions and operations can change, thereby changing the functional and spatial adequacy of some structures. Land use and infrastructure system development outside an installation's boundaries could affect physical, and facilities conditions on an installation, particularly for those site elements at installation entries and boundaries.

3-24. Data Display Alternatives.

- Tables of facility by type, occupant, size, category code and Land use (Figure 3-6)
- Facility condition mapping

3-25. Data Sources.

a. Installation:

- Real Property Office
    - Real property records
- Facility surveys

PREPARED 30 JUN 87 | BUILDING INFORMATION SCHEDULE | PCN AKA-003 ACO | A/OF 30 JUN 87

INSTALLATION NAME FORT STEWART GA | INSTALLATION NO 13305 | RELATION CODE 13305 | ARMY LOCATION CODE 13834

FACILITY NUMBER	CAT CODE	CATEGORY DESCRIPTION	CURR-USE CAT CODE	RECOMD CAT CODE	UTIL AVAIL BLDG	GROSS SQ FT	UM 2	QTY MEAS TOT	NC OF FLR	T	YR BLT	F R	C A D	CONSTRUCTION MATERIALS FNDTN	STRCTL	WALLS	ROOF	EST ECON LIFE	MCA NO.
SS9106	72320	LAVATORY BLDG	72320	72320	WSEXOLXX	963		.0	1	S	939			SL CR	BK NSS	BK BK	RAFBSC	2009E	
SS9107	72320	LAVATORY BLDG	72320	72320	WSEXOLXX	963		.0	1	S	939			SL CR	BK NSS	BK BK	RAFBSC	2009E	
SS9108	72320	LAVATORY BLDG	72320	72320	WSEXOLXX	963		.0	1	S	939			SL CR	BK NSS	BK BK	RAFBSC	2009E	
SS9109	72320	LAVATORY BLDG	72320	72320	WSEXOLXX	963		.0	1	S	939			SL CR	BK NSS	BK BK	RAFBSC	2009E	
SS9110	72320	LAVATORY BLDG	72320	72320	WSEXOLXX	1017		.0	1	S	941			SL CR	BK NSS	BK BK	RAFBSC	2011E	
SS9111	14185	CO HQ BLDG	14185	14185	WSETOLXX	1060		.0	1	S	942			SL CR	BK NSS	BK BK	RAFBSC	2012E	
SS9112	14185	CO HQ BLDG	14185	14185	WSETOLXX	1060		.0	1	S	942			SL CR	BK NSS	BK BK	RAFBSC	2012E	
SS9113	14185	CO HQ BLDG	14185	14185	WSETOLXX	1060		.0	1	S	942			SL CR	BK NSS	BK BK	RAFBSC	2012E	
SS9114	14185	CO HQ BLDG	14185	14185	WSETOLXX	1060		.0	1	S	942			SL CR	BK NSS	BK BK	RAFBSC	2012E	
SS9115	14185	CO HQ BLDG	14185	14185	WSETOLXX	1060		.0	1	S	942			SL CR	BK NSS	BK BK	RAFBSC	2012E	
SS9117	72111	EM BK W/O MS	72111	72111	XXEXOLXX	2556	PN	40.0	1	S	943			SL CR	BK NSS	BK BK	RAFBSC	2013E	
SS9118	72111	EM BK W/O MS	72111	72111	XXEXOLXX	2556	PN	40.0	1	S	943			SL CR	BK NSS	BK BK	RAFBSC	2013E	
SS9119	72111	EM BK W/O MS	72111	72111	XXEXOLXX	2556	PN	40.0	1	S	943			SL CR	BK NSS	BK BK	RAFBSC	2013E	
SS9120	72111	EM BK W/O MS	72111	72111	XXEXOLXX	2556	PN	40.0	1	S	943			SL CR	BK NSS	BK BK	RAFBSC	2013E	
SS9121	72111	EM BK W/O MS	72111	72111	XXEXOLXX	2556	PN	40.0	1	S	943			SL CR	BK NSS	BK BK	RAFBSC	2013E	
SS9122	72111	EM BK W/O MS	72111	72111	XXEXHLXX	2556	PN	40.0	1	S	943			CON CN	BK NSS	BK BK	RAFBSC	2013E	
SS9123	72111	EM BK W/O MS	72111	72111	XXEXHLXX	2556	PN	40.0	1	S	943			CON CN	BK NSS	BK BK	RAFBSC	2013E	
SS9124	72111	EM BK W/O MS	72111	72111	XXEXHLXX	2556	PN	40.0	1	S	943			CON CN	BK NSS	BK BK	RAFBSC	2013E	
SS9125	72111	EM BK W/O MS	72111	72111	XXEXHLXX	2556	PN	40.0	1	S	943			CON CN	BK NSS	BK BK	RAFBSC	2013E	
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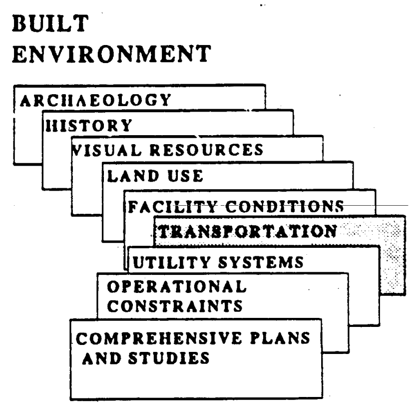
SS9127	72111	EM BK W/O MS	72111	72111	XXEXHLXX	2556	PN	40.0	1	S	943			CON CN	BK NSS	BK BK	RAFBSC	2013E	
SS9128	72111	EM BK W/O MS	72111	72111	XXEXHLXX	2556	PN	40.0	1	S	943			CON CN	BK NSS	BK BK	RAFBSC	2013E	

Figure 3-6

Building Information Schedule

F. TRANSPORTATION



3-26. Definition. Transportation planning should be integrated into the comprehensive planning process at the regional, vicinity and installation levels. Transportation planners, traffic and civil engineers, and comprehensive planners should all work to assure quality on-site transportation system development. Such transportation cooperation will include review of several factors, including street systems, transportation system management, Land use trip generation, mass transit, parking, bicycle and pedestrian systems, and service railroads. (See the transportation Planning Bulletin/Manual.)

3-27. Data Application.

a. Comprehensive planning efforts require in-depth analysis of traffic volume and trip generation data. Street layout and size and parking arc major issues to be addressed at the site level. Connections of military transportation Systems to local public systems require coordination between local and installation planners. Mass transit service to installation activities can alleviate some of the road and parking needs due to reduced private vehicle use. Management strategies such as carpooling and flexible work hours should also be considered in favor of expensive capital improvements. Specific direction on transportation data gathering can be found in the transportation Planning Bulletin/Manual.

b. Regional or local transportation plans can greatly influence installation transportation conditions. Military planners must be aware of proposed area transportation policies and projects so that they can tailor their plans or attempt to influence those policies accordingly. Because public transportation is coordinated at the regional and local government levels, transportation data should be readily available.

3-28. Relationship to Other Data. Major transportation facility development can greatly affect the built (particularly in urban areas) and natural environments, and thus relates to comprehensive Land use planning, natural site conditions (soils, topography, hydrology) and potential noise, safety, security, and air quality impacts. Energy usage and conservation relates directly to the available transportation systems, their efficiency in carrying passenger volumes and their fuel consumption.

3-29. Data Display Alternatives

- Existing and future transportation conditions (Figure 3-7)
- Transportation routing models (tabular and mapped on computer)
- GIS/CADD mapping with corridor data base linkages displaying conditions of roads, emergency routes, traffic volumes, signalization, bus routes, and "desire lines" for peak traffic

3-30. Data Sources.

a. State:

- Department of Transportation/Highways
  - State Transportation Plan
  - City/Regional/County/Transportation Studies/Plans

b. Regional:

- Regional Planning Agency
- Council of Governments
  - Area/regional transportation. plan (major thoroughfare plan)

- Regional Land use plan, transportation component
- Transit ridership data/reports
- Airport transportation studies
- Support service plan/report
- Traffic survey

c. County/Local

- Qty/Local Planning Department
- County Planning Department

d. Military:

- Military Traffic Management Command (MTMC)
  - MTMC Traffic Engineering Study
  - Installation traffic surveys and counts
  - Installation transportation plan
  - Installation layout/general site maps

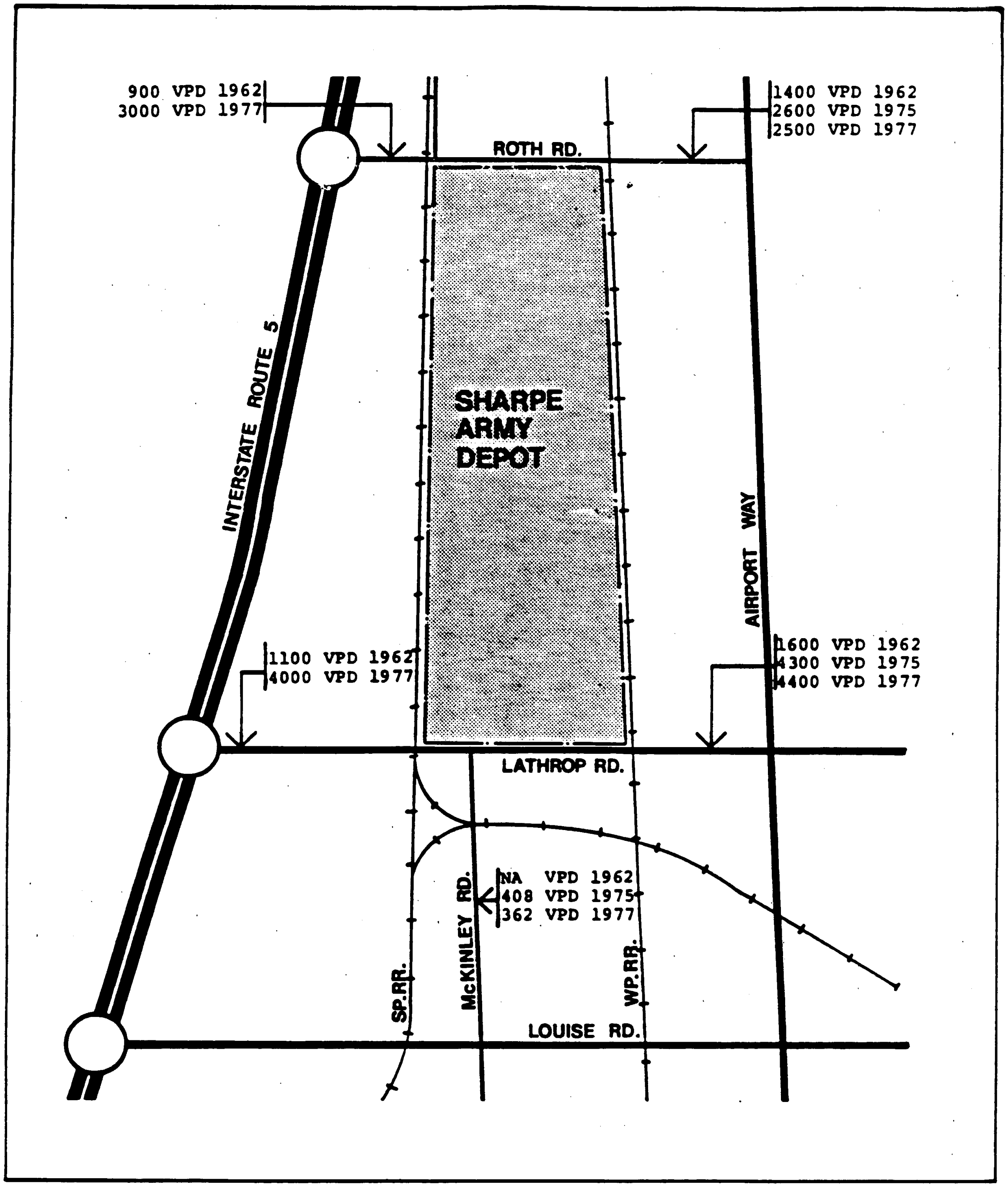
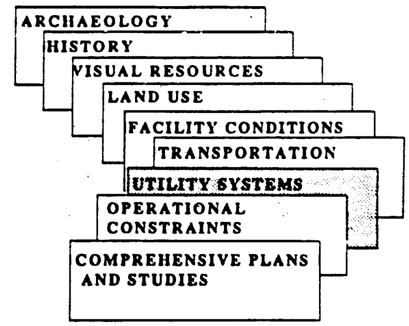


Figure 3-7

Traffic Volume - County Roads

G. UTILITY SYSTEMS

BUILT ENVIRONMENT



3-31. Definition. Utility systems are groups of devices, objects or organizations that form networks for distributing services (such as electric. power or water) to public private or institutional users. Municipal and installation utility systems provide the necessary services to military activities. Regional or municipal utility services include water supplies, treatment facilities and distribution systems; wastewater collection systems and treatment facilities; and solid waste removal and disposal systems and sites. Public utilities not usually under municipal control include electric power, natural gas and telephone services. All utility systems should be considered in installation comprehensive planning.

3-32. Data Application.

a. Utility systems information is directly applicable at the installation planning level. Existing capacity data and system layout plans arc available from local utilities for use as a detailed site-level baseline. Future plans and capacities are usually less defined.

b. Connections of installation utility systems to local public systems mandate the need for coordination between military and local public planners and engineers. Many utility systems are regional or city-wide in scope and administration; therefore, there is usually a great deal of data that is readily applicable to regional and complex studies. Long range utility goals, objectives and policies of local governments and authorities must be evaluated in regard to their potential impact on installation missions in areas served by those utilities. The military should play an active role in policy and goal formulation to assure the provision of installation utility requirements over the short and long term. Utility system location, particularly that of water and sewer, is a key urban growth determinant to be considered by military planners in terms of potential future encroachment pressures on military facilities at all scales

3-33. Relationship to Other Data.

a. Utility systems information relates to natural resource supplies (such as water, gas, and oil) that fall under the broad data categories of hydrology and geology. Utility systems location often coincides with that of transportation systems. Land use and comprehensive planning efforts are strongly dependent on utility capacity and location as determinants of urban growth.

b. Natural site conditions (soils, topography, hydrology, geology) affect utility placement, particularly underground utilities. Archaeological and historic sites may be unearthed or disturbed during underground utility placement

c. Utility systems placement relates to visual resources. Proper treatment of utility boxes, lines and inlets has the potential to enhance or prevent the destruction of the visual resources in an area.

3-34. Data Display Alternatives.

- CADD-generated or manually drawn utility system mapping by system type (Figure 3-8)
- Attribute files attached to graphic data base
- Utility modeling, demand forecasting, and capacity analysis

3-35. Data Sources.

a. Regional:

- Regional Planning Agencies
- Council of Governments
    - Utilities component, regional Land use plan

- Regional solid waste management plan, water consumption plan

b. Local/City:

- Utilities/Engineering Department
- Utilities Commission
- Sanitary District
  - 201 or 208 Facilities Plan
  - Water and sewer maps
  - Facilities planning studies
  - Consumption data
  - Public utilities maps (water and electric service)

c. Military:

- Base Civil Engineer/DEH:
  - Utilities Maps/Tabs
  - Utilities component of comprehensive plan
  - Updates on utility capability and expansion

d. Additional Sources:

- State Department of Natural Resources
- Water Resources Division, U.S.G.S.
- University traffic/transportation departments

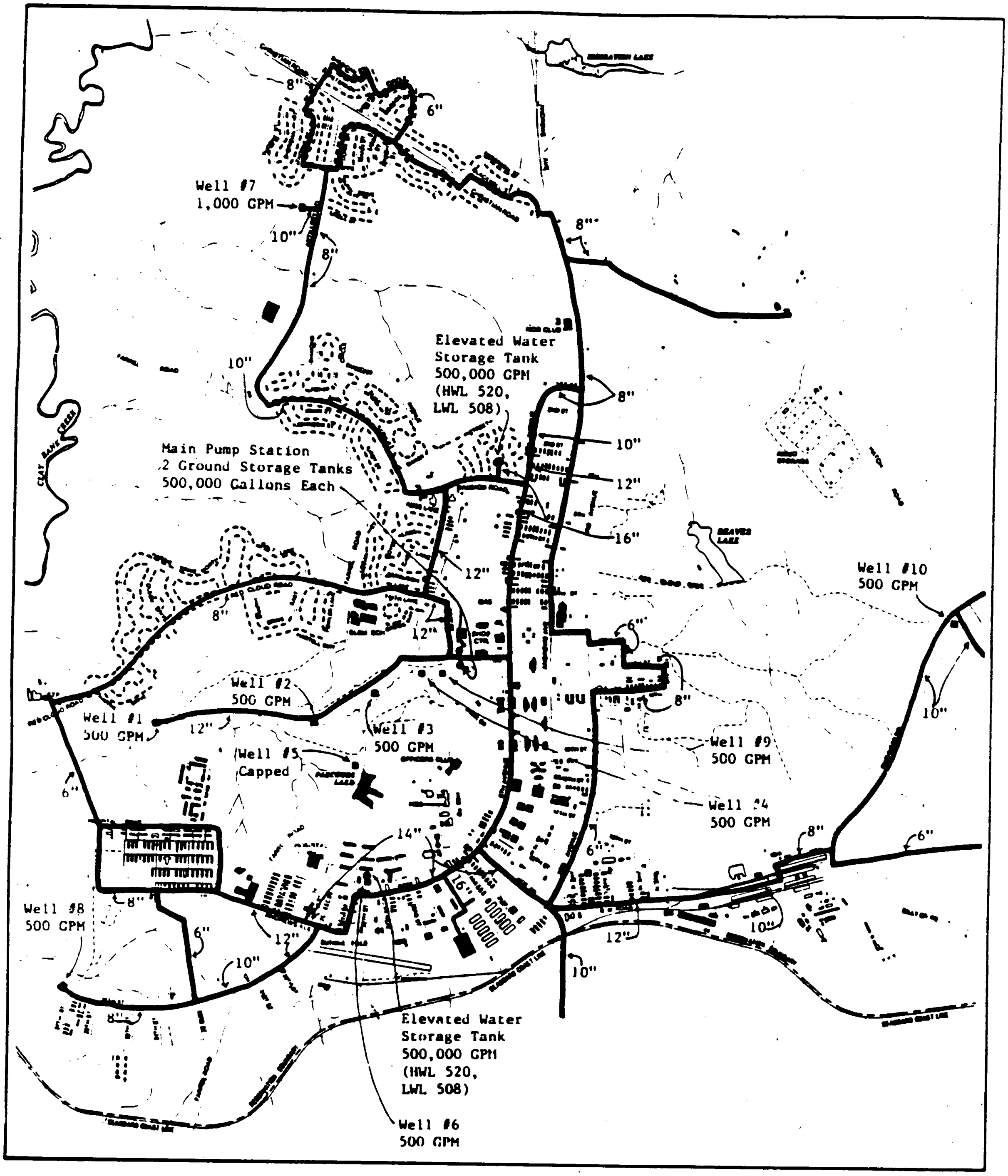
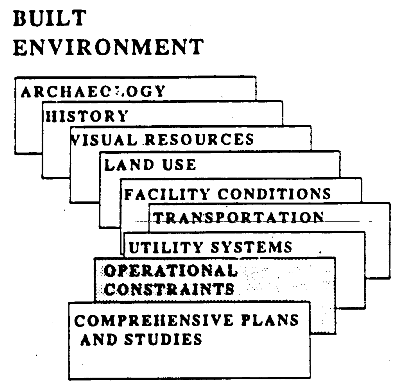


Figure 3-8

Water Distribution System

H. OPERATIONAL CONSTRAINTS



3-36. Definition. Operational constraints that most influence the comprehensive plan at military installations typically relate to safety-based military constraints. Therefore, these constraints manifest themselves in the form of facility construction and siting criteria intended to assure the separation of potential hazard/danger sources from other facilities, equipment and personnel at an activity. Special facility design and construction criteria may be applied to structures in order to contain or limit the potential hazards of explosive ordnance or dangerous substances to people, buildings or equipment. Safety distance setbacks or Land use limitations are usually required around potential hazard areas and facilities to provide protection. Operational military constraints are those related to ammunition and explosives; range safety; electromagnetic hazards; airfield safety hazards; security considerations; hazardous materials; and high noise levels.

3-37. Data Application.

a. Most operational constraints translate to safety zones, setbacks or separation distances that can be measured and applied to an installation constraint map. Explosive Safety Quantity Distance (ESQD) arcs, Crash and Accident Potential Zones (provided for in AICUZ/ICUZ planning activities), Electro-magnetic Radiation (EMR) setbacks, and other safety setbacks can be meshed with natural constraints to produce Land development suitability criteria for comprehensive planning.

b. Military operations affecting large areas of Land are most relevant to more general levels of planning. AICUZ/ICUZ-related Land use constraints are obvious large scale planning concerns, as well as bombing and firing range constraints. Hazardous material handling, storage and disposal can be potential environmental pollution threats to area and regional environments (e.g., air quality, water quality, noise). Military operations may also create general citizen health and safety concerns, particularly in areas near military airfields test ranges and hazardous substance and handling/storage sites. Military planning and policy decisions should be sensitive to potential area-wide impacts posed by installation operations.

3-38. Relationship to Other Data. Operational constraints relate directly to Land use; building condition/location; environmental systems and quality (air, water, Land); and transportation and utility systems locations. Natural site conditions (hydrology, soils, geology, topography) can have an impact on the location and structural condition of on-site ammunition/explosives and hazardous substance storage/handling facilities. Land use and infrastructure systems on and off an installation are affected by AICUZ/ICUZ-based noise and accident potential zone locations at airfield Gunnery, target and bombing range activities can create noise and vibration impacts on and off-site. Personnel safety and comfort can be threatened if building conditions are inadequate to prevent explosive-related damage. Transportation and pedestrian systems can affect building and base security, particularly as it relates to site building access. Adjacent Land use types and intensity of development can also affect installation and site perimeter security.

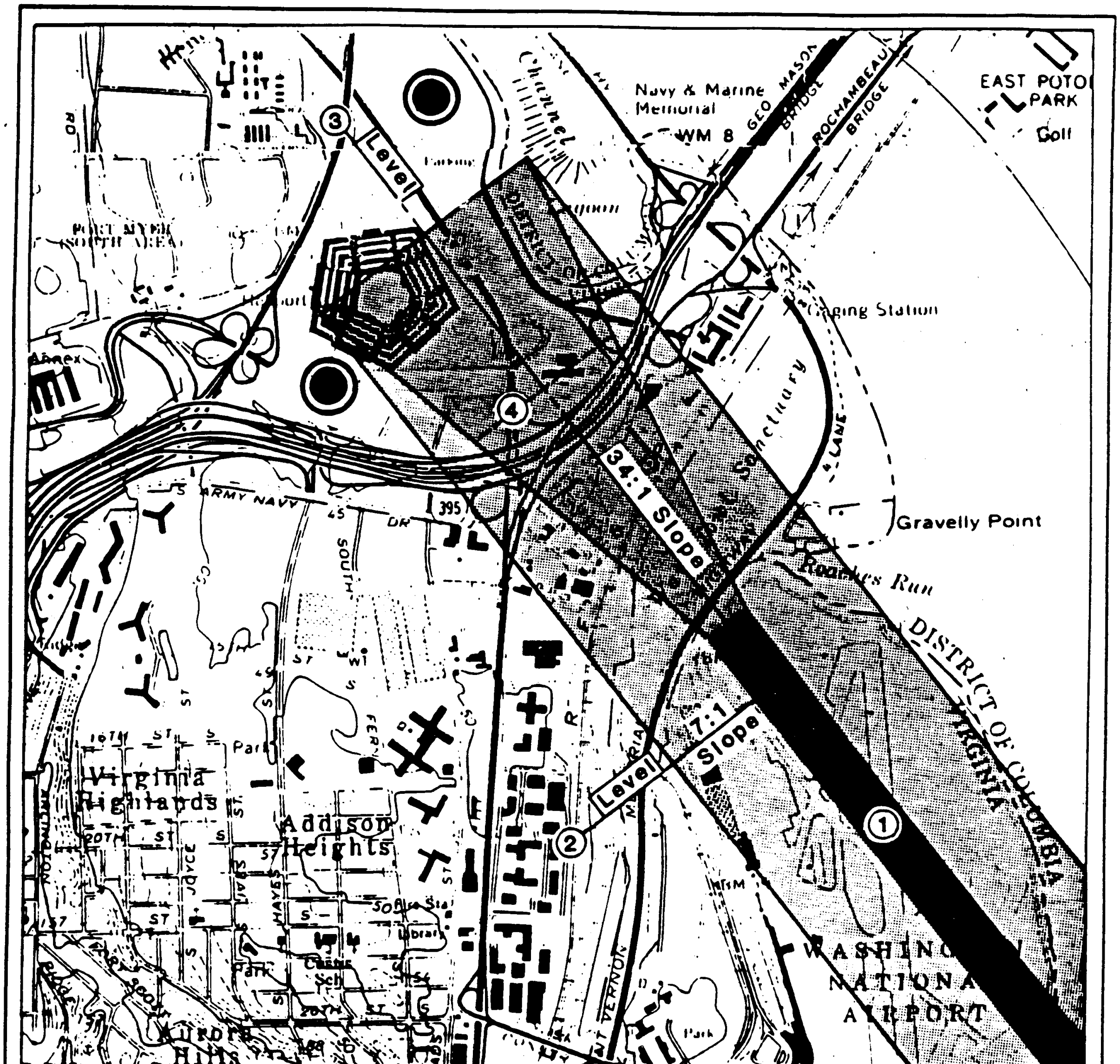
3-39. Data Display Alternatives.

- CADD/IGIS or manual mapping of constraints and opportunities analysis

3-40. Data Sources.

a. Military:

- Maps of restricted areas
- Maps and standard operating procedures for training facilities and services of training areas
- Maps of aircraft zone, areas, airspace (Figure 3-9)
- Maps with ESQD arcs
- Electromagnetic Radiation Hazard Areas maps
- Maps indicating site-related security constraints
- Line-of-sight clear zones
- Manuals specifying procedures for determining Explosive Substance Quantity Distances and other required setbacks



Legend

1 Runway at Elevation 0'

2 Horizontal Surface at 150' Above Established Airport Elevation to 5000' From Edge of Runway

3 Horzontal Surface at 150' Above Established Airport Elevation to 10,000' From End of Runway

4 90' Above Airport Elevation

● Primary Building Sites – 150' Height Limitation

Scale

0 500 1000 2000

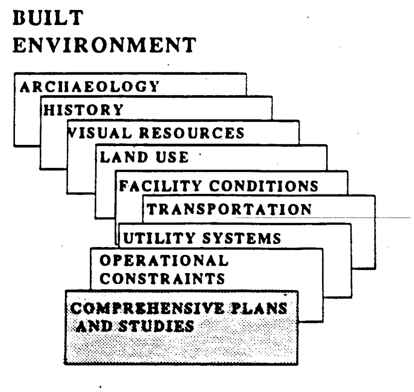
North

Figure 3-9

FAA Height Restrictions

I. COMPREHENSIVEPLANS AND STUDIES

3-41. Definition.



a. Comprehensive plans and studies are broad examinations or analyses of current and potential planning issues facing the government(s) and residents of a geographic, demographic or jurisdictional area. These studies usually examine a broad range of issues in varying levels of detail so that governments may identify critical impacts and the mitigation alternatives to them. Comprehensive plans to consider are Land use plans, capital improvements programs, fiscal impact analyses, infrastructure plans, and community facilities and recreation/ open space plans.

b. Comprehensive plans and studies today are usually policy-oriented; they do not provide detailed physical plans for all city development. They may provide only a general guide to what is desired for future development. Land use and public infrastructure (roads, water, sewer, public facilities) are key focal points of current comprehensive plans, as are policies and general plans for directing the growth and location of these elements. Every local government has a unique set of circumstances and needs that dictate the nature of its comprehensive plan.

3-42. Data Application.

a. Comprehensive plans and studies provide general information for use at the installation planning level. Major city growth policies and directions can assist military planners in assessing the general context of an activity and hence the potential for encroachment. More detailed analyses of zoning and Land use documents may be required to provide the necessary level of detail to assess any specific site's municipal planning impacts. Local government capital improvement programs usually identify specific proposed projects and describe their purpose, size, location, cost and anticipated construction date. This information can be invaluable to military planners in assessing municipal services availability and as an indicator of nearby private development growth rates and locations.

b. Comprehensive plans are conducted on a city, county or region-wide basis. Issues are much the same in both municipal and large scale military planning (e.g., transportation, utilities, housing, economic development trends, social and community services, Land use, encroachment). The military can influence regional and local comprehensive planning studies through an active participation in the public planning process. This participation provides a forum for presenting the benefits of the military presence (such as housing and retail demand and the provision of jobs to local residents).

3-43. Relationship to Other Data.

a. Comprehensive plans can provide information in virtually all data categories,' including the physical, biological, cultural, socioeconomic, and built and regulatory environment systems of information. The primary focus of comprehensive plans tends to be Land use change and the direct and secondary causes and impacts of such change. The development process, environmental and community concerns, and the economic well-being of the community are major concerns The comprehensive nature of these studies means that they touch upon many planning issues and provide overview data for decision-making, but detailed data in each category will be found in specific preliminary studies on those topics.

3-44. Data Display Alternatives.

- Overlay mapping of plan components using CADD/GIS or manual mapping techniques
- Tabular data and text

3-45. Data Sources.

a. Regional:

- Regional Planning Agency
- Council of Governments
    - Regional Land Use Plan or Comprehensive Plan

b. Local/City:

- Planning Department
    - Comprehensive Land Use Plan (Figure 3-10)

c. Military:

- AICUZ/ICUZ
- Comprehensive Plan
- Land Use Compatibility Studies

d. Additional Sources:

- County planning department
- State Department of Natural Resources

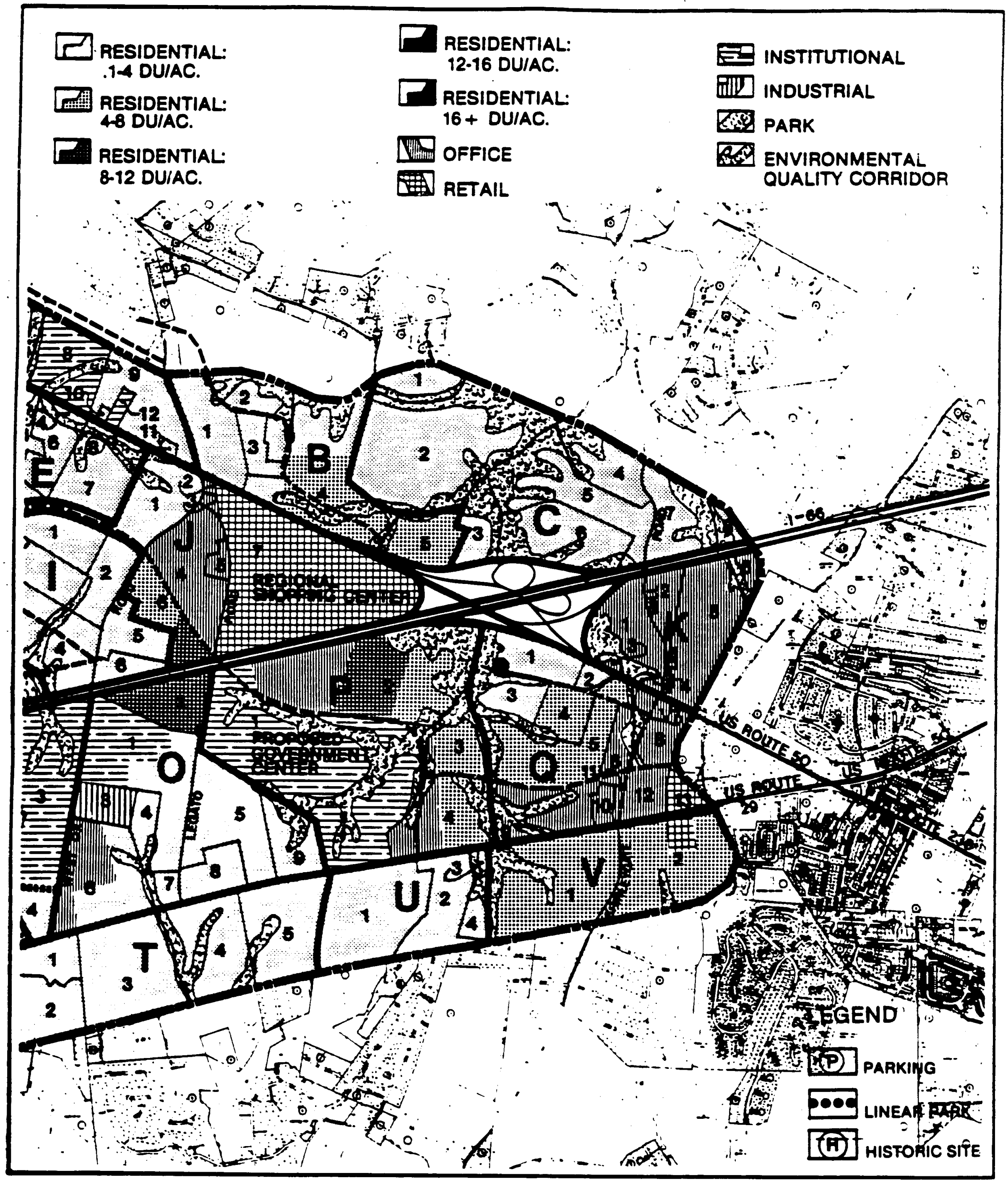


Figure 3-10

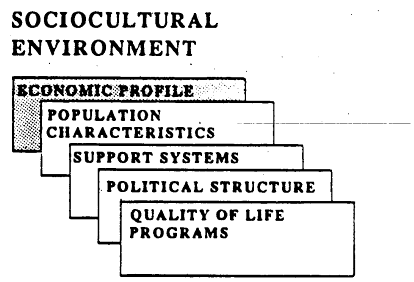
Comprehensive Plan

CHAPTER 4. THE SOCIOCULTURAL ENVIRONMENT

Chapter 4

The Sociocultural Environment

A. ECONOMIC PROFILE



4-1. Definition. The economic profile describes and analyzes production, distribution and consumption of goods and services in both the private and public sectors. It provides an overview of the existing conditions that characterize an area's economy, measures that economy's productive capacity and outputs, identifies its dependencies and sensitivities to externalities, appraises its ability to support changing demands for goods and services, and assesses the trends and forces that will change the economic status of the community.

4-2. Data Application.

a. The economic profile enables the planner to evaluatethe relationships between the economic functions of the military installation and those of its host community so that inefficiencies and unintentional costs can be avoided through advanced planning. Primary economic factors to evaluate in the planning effort arc employment, income, occupational structure, and fiscal data.

b. Principal economic issues relate directly to specific demands and effects of the installation and its functions and personnel on the host economy. The availability and quality of retail, banking, and other support services in the community may influence decisions regarding their provision by the military. In the public sector, tile quality and capacity of specific services and facilities to satisfy activity requirements may determine facility location and provision. The availability of selected civilian occupational skills may affect military staffing decisions.

4-3. Relationship to Other Data. Economic data, indicators, and analyses are inextricably related to population characteristics, transportation systems, physical systems, and political structure.

4-4. Data Display Alternatives.

- Tabular data and text (Figure 4-1)

4-5. Data Sources.

a. Federal:

- U.S. Census Bureau
  - Census of Manufacturing
  - Census of Mineral Industries
  - Census of Retail Trade
  - Census of Selected Service Industries
  - Census of Transportation
  - Census of Wholesale Trade

b. State:

- Department of Commerce
- Department of Labor
- State Employment Service
  - Employment statistics for state
  - Population statistics
  - Industrial/occupational structure, statistics, forecasts

c. Regional:

- Regional Planning Agency
- Council of Governments
  - Employment statistics for region (labor force, occupational structure, unemployment and employment rates, trends in labor force, income sources)

- Population statistics (size, age, distribution)
- Industrial/occupational structure statistics

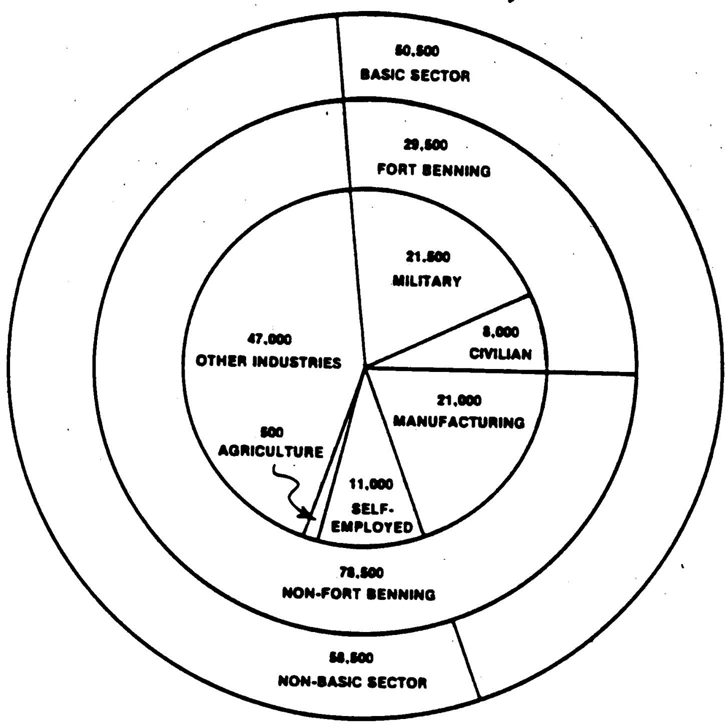
d. Local:

- Office of the Mayor
- Planning Office
- Planning and Economic Development Offices
  - Employment, population and occupational statistics
  for city, reports, forecasts

e. Additional Sources:

- Chamber of Commerce
- County Planning Office
- U.S. Army COE Civil Engineering Research Lab
  (CERL)/Environmental Technical Information System

METROPOLITAN EMPLOYMENT



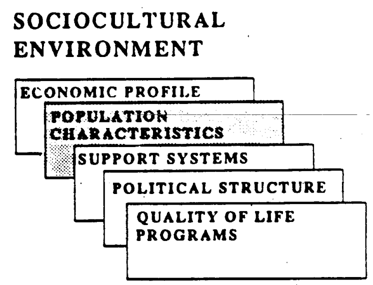
EMPLOYMENT TRENDS
COLUMBUS SMSA,
1970 and 1976

	1970		1976	
	Number	Percent	Number	Percent
Civilian				
Non-farm wage and Salary	69,000	62.2%	76,000	69.7%
Other Non-farm	11,000	9.9%	11,000	10.1%
Sub-total	(80,000)	(72.1%)	(87,000)	(79.8%)
Agriculture	1,000	0.9%	500	0.5%
Total	81,000	73.0%	87,500	80.3%
Military	30,000	27.0%	21,500	19.7%
GRAND TOTAL	111,000	100.0%	109,000	100.0%

Figure 4-1

Economic Profile

B. POPULATION CHARACTERISTICS



4-6. Definition. The characteristics of a population describe its size, distinguishing attributes, locational distribution, and trends. As these characteristics are easily influenced by non-demographic factors, they constitute an important reference base for any planning study that could generate actions to which the resident population may be sensitive. Analysis of an area's population characteristics provides the planner with indicators of the area's general economic health as well as information regarding special conditions that may impose limitations or represent advantages in the context of military planning. The primary population planning factors in the gathering of planning data are (1) population size, (2) age distribution, (3) sex distribution, (4) income distribution, (5) ethnic/racial composition, (6) educational level, (7) family composition, (8) locational distribution, and (9) growth trends.

4-7. Data Application.

a. The population dynamics in the area immediately surrounding a military installation can be identified and evaluated through analysis of census-tract level data. While these population conditions could impose some operational constraint on the installation, it is more likely that the installation may place demands on the population in the broader community. Thus, the plan should take cognizance of the population characteristics in tile host community and region and their sensitivity to the changes which proposed installation activities and planning decisions may generate. This knowledge can assist military planners in avoiding unnecessary disruption to local population trends.

b. Population characteristics and trends are best examined at the regional scale as their complete pattern and locational differences can only be identified in a large geographic context. Examination of population trends regionally reveals changes in the total numbers, migration patterns, and internal shifts in composition; in addition, it can identify intra-regional population shifts that would not be evident at a smaller geographic unit of analysis. For example, a region may be experiencing net immigration, but one jurisdiction in the region is attracting older migrants while another area is gaining only younger migrants. The availability of population data is greater at the regional level and thus the analysis at this scale can be more sophisticated and yield higher quality results. Regional population analyses establish the analytical framework for installation comprehensive planning assessments.

4-8. Relationship to Other Data.

a. The characteristics of the population and their rate and direction of change are closely tied to the health of the area's economy and the quality or life offered in the community. Just as the increase or decrease of employment opportunities will induce migration to or from the area, the size, diversity, and quality of the population can induce growth or decline in the economy. Population translates into demand for private sector services, public services, housing, and transportation. Population has a physical dimension: its increase requires land for new housing and services, and its decrease results in the abandonment of land, housing and infrastructure. In the basic economic equation, population represents the demand element (the `consumer) as well as the supply (labor). The consumption levels of the population are governed largely by the income the population earns by means of working in the economy. Greater earning power generates increased consumption potential. Thus, the relationship between population and economic status is inextricable.

4-9. Data Display Alternatives.

- Spreadsheet/tabular data (Figure 4-2)
- Maps illustrating geographic distribution of population characteristics

4-10. Data Sources.

a. Regional:

- Regional Planning Agency
- Council of Governments
  - Regional master plan
  - Information on local government structure and personnel

b. State:

- State Data Center (call Census Bureau for address in each state - it is usually a state department or university)
- State Single Point of Contact

c. County:

- Planning Office
  - County Master Plan
  - Growth management policy information
  - Information on local government structure and personnel
- Department of Education

d. Local:

- Office of the Mayor
- Planning and Development Office
  - Voter information
  - City master plan information on local government structures and personnel
  - City department of education

e. Additional Sources:

- Federal:
  - U.S. Department of Commerce
  - Bureau of Census

    Census of Population and Housing

    U.S. Army COE Civil Engineering Research Lab
    (CERL)

f. Private:

- National Clearinghouse for Census Data Service
  (Census Bureau has list - most charge for their services)

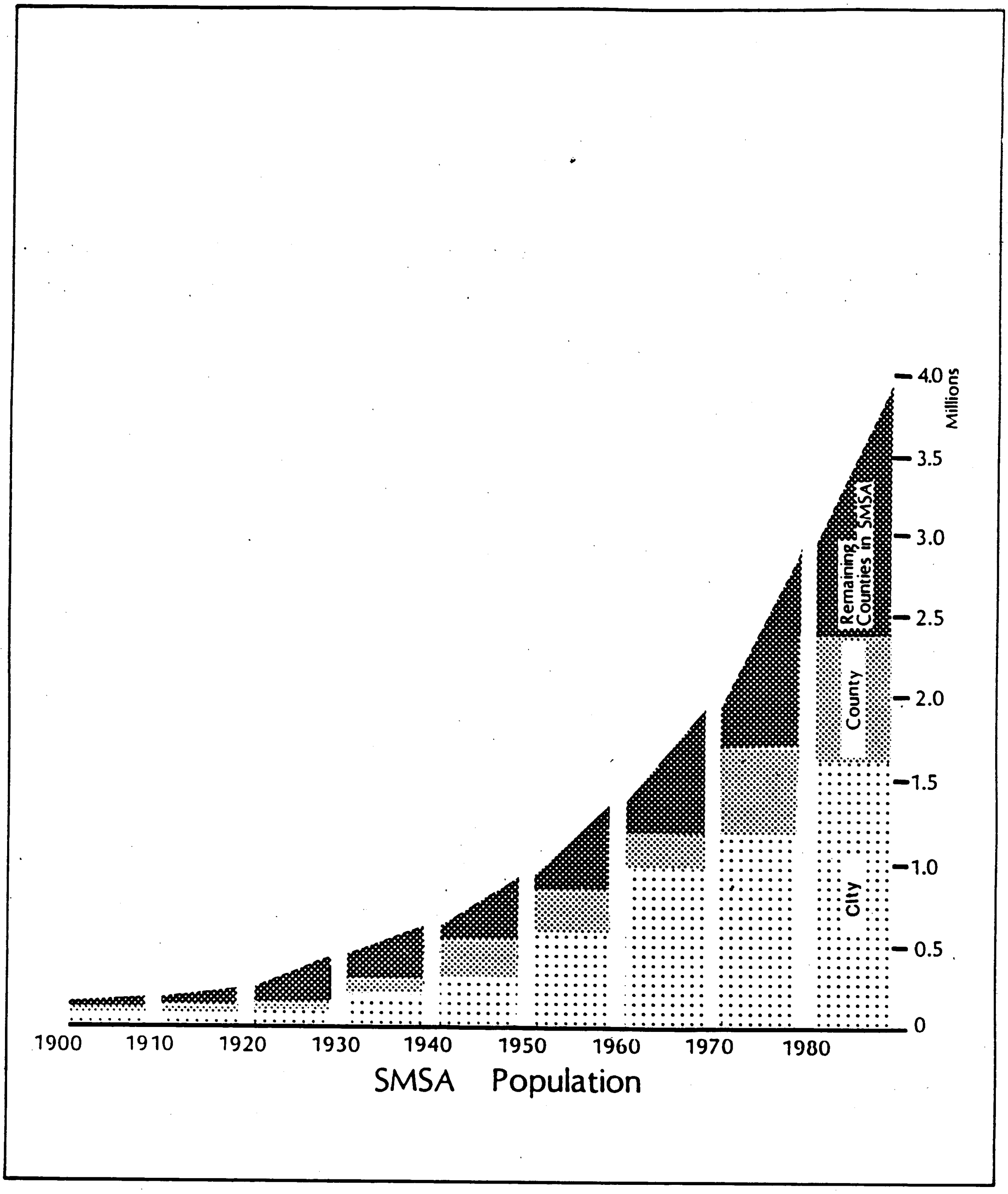
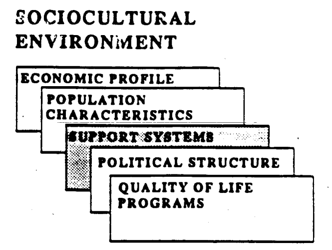


Figure 4-2

Population Characteristics

C. SUPPORT SYSTEMS



4-11. Definition. Support systems encompass all facilities and services both on and off an installation and arc intended to serve the quality of life requirements of military personnel. Support systems incorporate the broad array of community facilities and services normally provided by local government. Primary support systems to consider in installation planning include educational facilities, health care, sanitation, recreation, fire and police, and social services. Also included are community assets such as housing, shopping, and support institutions (organizations, clubs, churches) which military personnel may require to support their non-military activities.

4-12. Data Application.

a. The analysis of the support system has as its major objective the determination of the host community's suitability and capacity to satisfy the off-duty needs of military personnel and their families. This information helps the military planners assess the quality of a community as a place to live, based both on its housing conditions and on the availability of public and private facilities and services to support an acceptable quality of life for military personnel living off the military installation. Facilities, services, and requirements on and off an installation should be analyzed in order to determine those that are insufficient within the community and should be furnished by the military. In cases where new military related demands are to occur, these additional needs can be anticipated in advance and facilities and services expanded by the community or military as appropriate.

b. The study of support systems has its major relevance at the jurisdictional level as most facilities and services are provided at the city-wide scale. An installation contained within a single local jurisdiction or in several contiguous local jurisdictions can be affected by geographic differences in the quality of local support systems. The effect on installations of these relative differences, both in housing suitability and affordability and in public and private community facilities and services, could provide the basis for decisions to concentrate the provision of military support systems at the most central segment of the installation.

4-13. Relationship to Other Data. The population dynamics in the community at large, exclusive of military personnel and dependents, constitute the demand for services. Where population growth outpaces service provisions, these facilities will be over capacity. Similarly, where a community's fiscal position is weak or where the economic base is deteriorating, the supply of support system services will be limited and their quality ~s likely to be eroding.

4-14. Data Display Alternatives.

- Mapping of off-installation support system locations (Figure 4-3)
- Spreadsheet/tabular data

4-15. Data Sources.

a. State:

- Office of State Budget and Management
- Department of Commerce
- Department of Planning and Budget (State Data Center, Information Office, and Research and Planning Service)
  - Census Data of Population and Housing
  - State Statistical Abstract
- State Single Point of Contact

b. Regional:

- Regional Planning Agency
- Council of Governments
  - Maps of school districts, park districts
  - Regional comprehensive/land use plan
  - Housing studies, plans
  - Support services plan
  - Regional open space/recreational plan
  - Demographic studies
  - Growth trends reports

c. Local:

- City Planning Office
  - Local/city comprehensive/land use plan
  - List/map of churches, schools, etc.
  - Demographic studies
  - Growth trends reports
  - Housing surveys
  - Yellow pages
- Public Works Department

d. Additional Sources:

- County Planning Office
- County School Superintendent
- Utilities

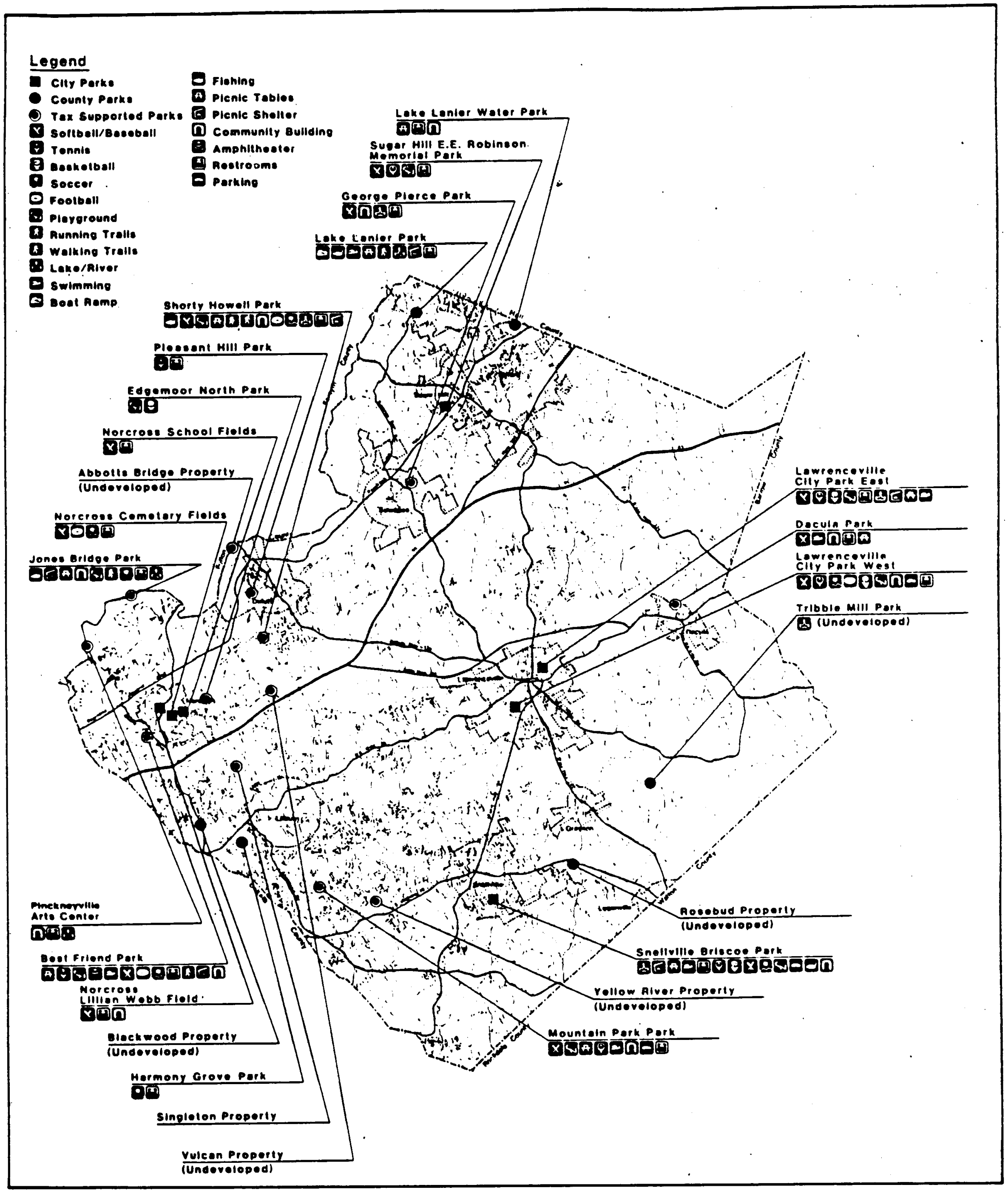
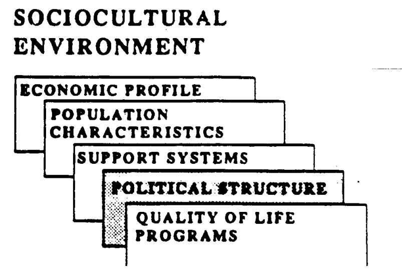


Figure 4-3

Recreation Facilities

D. POLITICAL STRUCTURE



4-16. Definition. The political structure of an area describes the organization of government, the area's intergovernmental relationships, and the relationships between special interest groups and governmental units in the exercise of public authority and the resolution of conflict in the context of the public interest. These conditions establish the institutional framework within which issues and problems affecting the interests of the community can be examined and resolved. This framework consists of existing government units and their interrelationships, local organizations representative of special interest groups, and the political process that establishes the rules by which disputes are resolved in a public forum. Knowledge of this structure and its process permits military planning decisions to be coordinated appropriately with the interested governmental and organizational units, contributes to accountability within the decision-making process, and establishes the means by which controversial issues may be resolved to the interest of all affected parties. Primary factors in review of political structure are governmental organization, intergovernmental relationships, private organizations, and political process.

4-17. Data Application.

a. The local political structure, including government and nongovernmental organizations, formal and ad hoc, is most directly involved with site specific issues. Local governmental units and local action groups are easily identified and have the greatest relevance. The political process governs the behavior of these organizations at all levels and therefore is relevant at this scale of planning.

b. The types of planning decisions exercised at the regional level correspond with whole jurisdictions and groups of local jurisdictions, in contrast to the site specific level where the planning concern is generally quite localized. The political process governs the behavior of all organizations and therefore is relevant at this scale of planning. Regional studies should establish the political structure operation at this scale; this is composed of federal, state, regional, and local governmental units and their intergovernmental linkages. Some nongovernmental organizations may operate at this scale (e.g., an association or environmental group) and should be documented accordingly. The processes and regulations guiding the behavior (responsibilities and authorities) of these organizations and groups should be identified.

4-18. Relationship to Other Data. Political structure data describe the organizational framework within which development decisions are formulated, evaluated, and implemented. These data relate to other planning information in an indirect manner. As a provider of services to military personnel residing in the community and to the installation, the political structure affects the local quality of life as well as public facility and service requirements on an installation. The presence of well organized and informed special interest groups can contribute important information input as well as exert constraints on military planning decisions that may ultimately affect installation operations.

4-19. Data Display Alternatives.

- Data base of political structure, jurisdictions
- Maps of jurisdictions (Figure 4-4)

4-20. Data Sources.

a. State:

- Department of Labor
- Department of Commerce
- State Employment Service

- State Budget and Management
- Statistical Service/Data Center
    - Population statistics, census tracts and maps (at state scale)
    - Demographic statistics
    - Population trends
    - Migration statistics

b. Regional:

- Regional Planning Agency
- Council of Governments
    - Population statistics (size, age distribution), census tracts, maps
    - Demographic statistics
    - Regional Land Use Plan
    - Population trends

c. Local:

- Planning Department
    - Population statistics, census tracts and maps (at local scale)
    - Population trends
    - Employment statistics

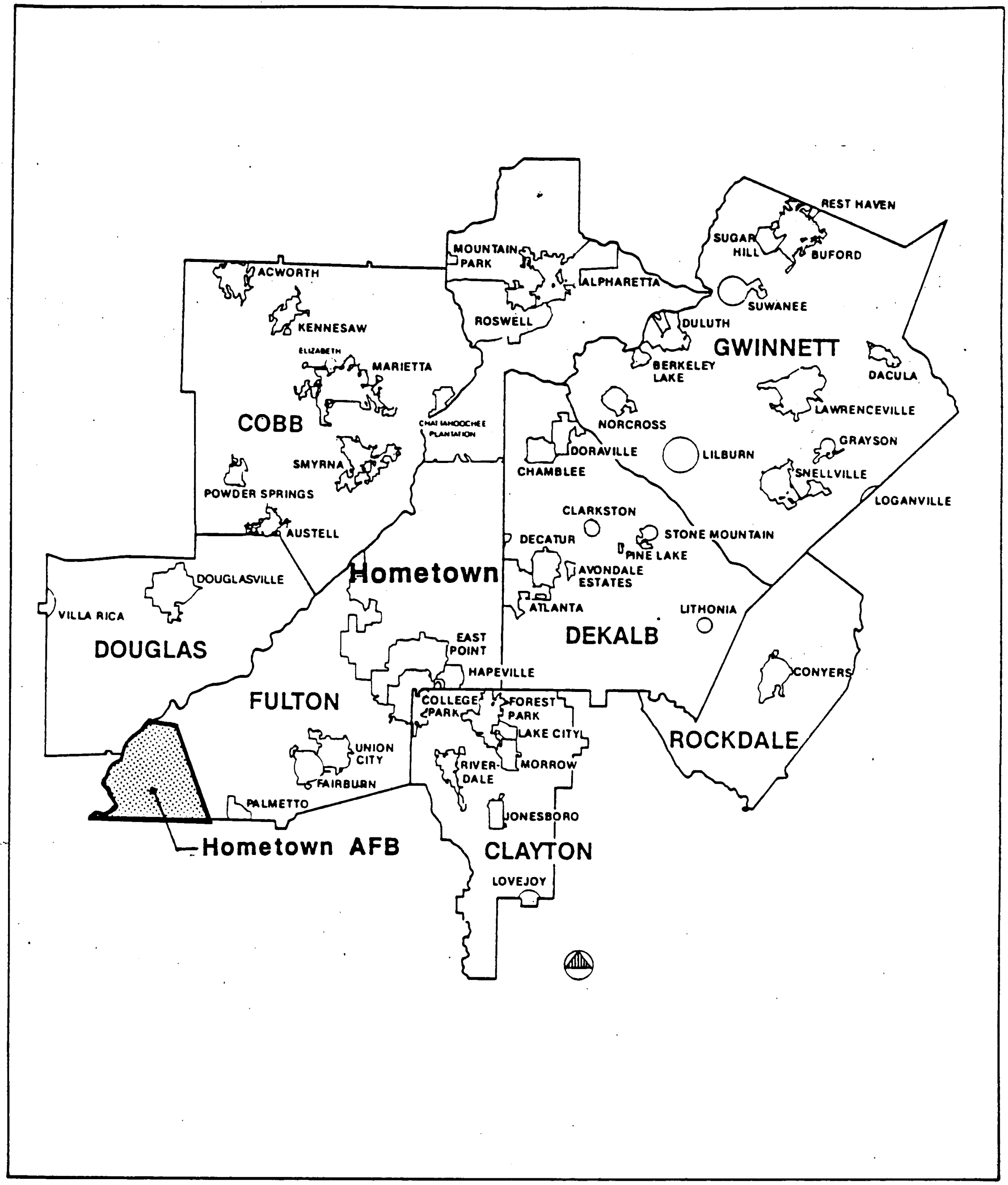
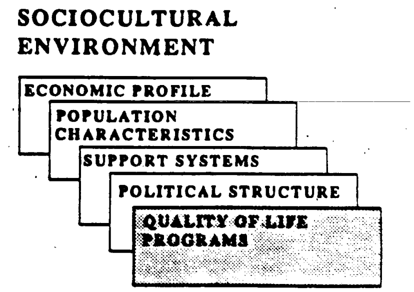


Figure 4-4

Political Jurisdictions

E. QUALITY OF LIFE PROGRAMS

4-21. Definition.



a. Quality of life programs are efforts to enhance life for an installation's residents and employees of an installation through programs, policies, and physical planning implementation. The primary factors contributing to quality of life at an installation include social and recreational programs, services, and the quality of the natural and built environments.

b. Quality of life is promoted through a blend of physical, social, and services ingredients. Expanded delivery of medical care, provision of day care services, improved educational opportunities, and extended hours for commissary services are all examples of programmatic improvements which can improve quality of life beyond facility Solutions. However, quality of life should be stressed as the common thread linking all segments of comprehensive planning.

4-22. Relationship to Other Data.

a. The interrelationship of data to quality of life programs is extensive and at times intangible. Efforts to put these programs in place goes beyond criteria of physical demands and economic feasibility; in many eases, quality of life encompasses nonquantifiable values and subjective judgments. However, the data relating to quality of life include natural environment categories of open space, vegetation, passive outdoor recreation opportunities, water quality, air quality, and noise; built environment categories of facility conditions and transportation; and sociocultural environment categories of economic profile, population characteristics, and support systems.

4-23. Data Display Alternatives.

- Map of Quality of Life Facilities
- Surveys of installation personnel

4-24. Data Sources.

- Surveys of installation personnel (see Figure 4-5)
- National Recreation and Parks Association
- AFR 86-2, DoD 4270.1-M, Architectural and Engineering Instructions

5. The following questions ask about how you spend your leisure time. Listed below are various recreational facilities that may be available on your base. Whether you live on-or off-base, please check one box to show how often you use each facility.

On-Base Facilities	Check here if not available on your base	I go to these on-base....... Very Often	Fairly Often	Not Too Often	Rarely or Never
a. Clubs (e.g., Officer, NCO, etc.)	☐	☐	☐	☐	☐
b. Golf course	☐	☐	☐	☐	☐
c. Outdoor sports facilities (e.g., tennis courts, softball diamonds, track)	☐	☐	☐	☐	☐
d. Indoor sports facilities, (e.g. handball and racquet ball courts, weight lifting equipment)	☐	☐	☐	☐	☐
e. Swimming pool at the Club	☐	☐	☐	☐	☐
f Picnic grounds	☐	☐	☐	☐	☐
g. Stables and riding trails	☐	☐	☐	☐	☐
h. Bowling alleys	☐	☐	☐	☐	☐
i. Billiard or pool rooms	☐	☐	☐	☐	☐
j. Recreation center (e.g. meeting rooms, game rooms, hobby shops)	☐	☐	☐	☐	☐
k. Base theater	☐	☐	☐	☐	☐
l. Library	☐	☐	☐	☐	☐
m. Other (PLEASE DESCRIBE)					
____________		☐	☐		
____________		☐	☐		
____________		☐	☐		
____________		☐	☐		

Figure 4-5

Sample QOL Survey

CHAPTER 5. COMPREHENSIVE PLANNING

COMPUTER APPLICATIONS

Chapter 5

Comprehensive Planning Computer Applications

A. INTRODUCTION

5-1. Value of Using Computers in the Planning Process. Many components of the comprehensive planning process can be more efficiently conducted using a computer system designed for storage and analysis of graphic and tabular data. Computer-assisted planning usually requires a considerable initial investment to build a digital data base. The payback in efficiency will be realized in the long term because of the ongoing and repetitive nature of the comprehensive planning process. Several types of computer systems are available to aid planners in their work. This chapter provides a discussion of:

- Two types of computer systems that aid in planning (I) Computer-Aided Design and Drafting (CADD), and Geographic Information Systems (GIS);
- Two types of available digital data, photogrammetric and remote sensing data (II); and
- Two specialized planning application techniques used in comprehensive planning, visual simulation and environmental modeling (II) (Figure 5-1).

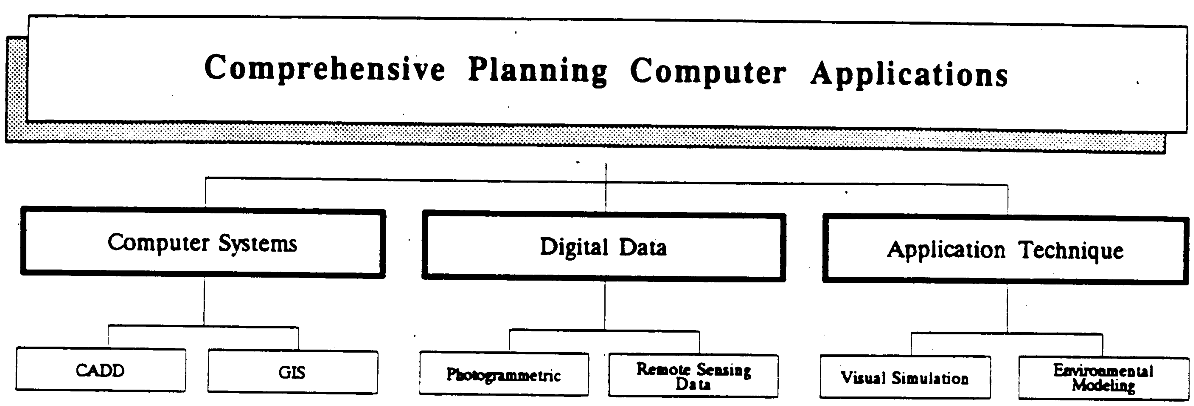
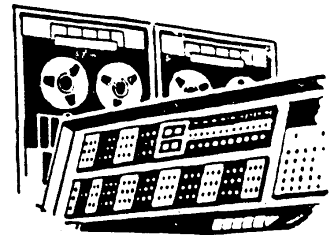


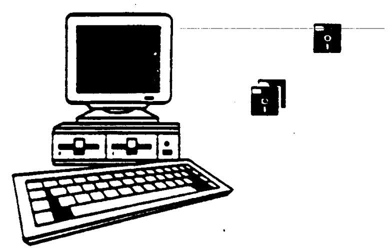
Figure 5-1
Chapter Diagram

B. COMPUTER GRAPHICS

5-2. Overview of Computer Types.



a. Computers represent the most innovative and, perhaps, the fastest changing area of technology today. This manual provides an overview of the current technology and its potential application to comprehensive planning. As these computer tools evolve and can accomplish more work in less time and at less cost, their use in planning will also likely evolve. As computers become more powerful, they still serve only as tools to the planner; the planner must provide the understanding of planning issues in order to use the tools successfully.



b. Computers have evolved from very large machines occupying several rooms and capable of only simple mathematical functions. Today, very powerful machines are programmed to be artificially intelligent, yet are portable and can reside on a desktop. Mainframe and minicomputers can be accessed by several terminals (usually "dumb" terminals) from different remote locations. The central processing unit (CPU) performs work for many by slipping in and out of the operations it must perform, a process known as "multi-tasking." These systems are characteristically very centralized and require significant system management expertise. Microcomputers, also known as desktops or personal computers (PCs), can perform only one task at a time for only one user at one time. The most recent hardware advances have been in the development of powerful workstations. Each workstation is dedicated to one specific application, such as computer-aided design, and is configured with hardware components to maximize application efficiency.

c. Computers have advanced rapidly in various computer graphics applications. Monitors and graphics cards are capable of high resolution display in thousands of colors. Color electrostatic and laser printers, along with multi-pen plotters, produce high-quality drawings. Advanced graphics software uses the principle of fractals to represent the forms of nature and to simulate reflection, shade, and shadow.

d. Whether based on a mini-computer system, workstation, or desktop microcomputer, an Automated Graphics System (AGS) configuration must include the following components, as shown in Figure 5-2, some of which can be shared from remote locations:

1 Central processing unit
2 Display monitor (output device)
3 Keyboard (input device)
4 Hard disk drive or floppy disk drive (storage device)
5 Plotter or printer (output device)
6 Digitizing tablet and/or mouse (input device)
7 Automated graphics software

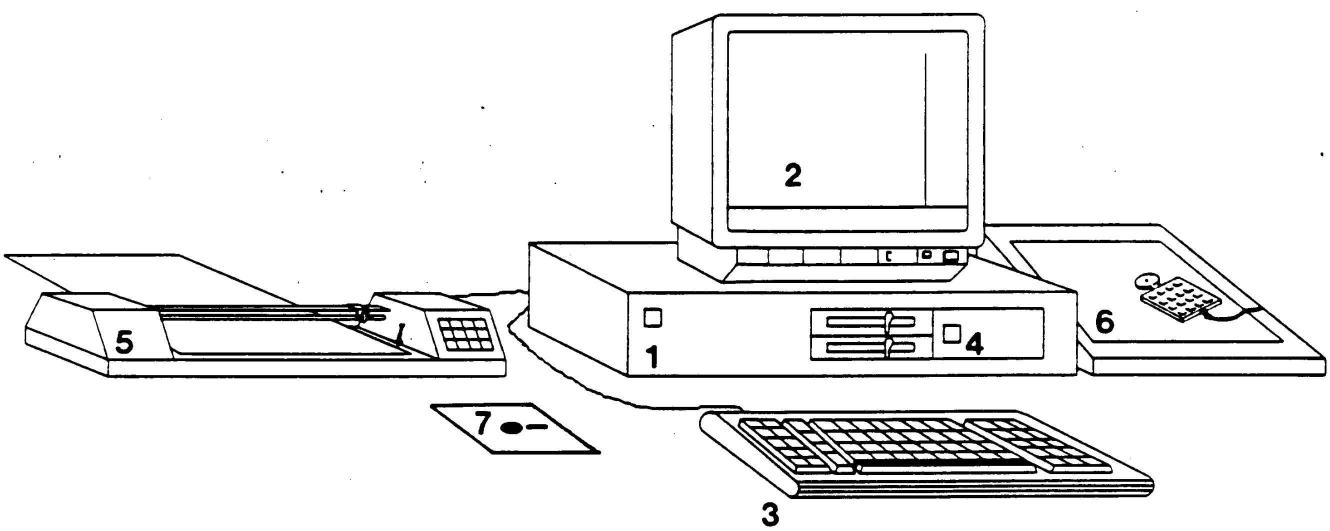


Figure 5-2
PC-CADD Workstation

e. The future configuration for Air Force installation needs currently being planned is an Integrated Graphics System. It is envisioned as an interactive system with sophisticated input, storage, manipulation, and output capabilities comprised of four components:

- Computer-Aided Design and Drafting (CADD)
- Automated Mapping/Facilities Management (AM/ FM)
- Facility Space Management (FSM)
- Geographic Information System (GIS)

5-3. Data Storage.

a. Digital data can be stored in a variety of formats and on a variety of magnetic and optical media; they are briefly discussed here for reference in later sections of this chapter. Data storage formats (i.e., the way in which data is organized in a file on a storage medium) vary significantly for graphic as well as tabular data. Many computer programs that manipulate tabular data provide the user with options to store files in the program's own unique format or in a generic format known as ASCII (American Standard Code for Information Interchange). ASCII format readily permits the transfer of this data between different programs and systems. Special translation programs that will translate files from one specific digital format to another are also available. Special graphic versions of ASCII formats include SIF, used for Intergraph files, and DXF, used for AutoCAD files. When obtaining tabular data from a vendor or a consultant, the planner should ensure the files received are in the same format as the program on which it will be used, or in ASCII format. If a planner has, for instance, inventoried and analyzed existing buildings at the installation, the data could be recorded using a spreadsheet or data base program. The magnetic copy must be compatible with the planner's program in order to use the information. Delivery of graphic data files must similarly be coordinated for format compatibility.

b. For graphic data, special translation programs are usually required because there are many generic graphic formats, such as digital line graph (DLG), and because storage of graphic data is much more complex. Digital graphic data require significantly more storage space than tabular data; for a large installation, each sheet or layer of the comprehensive plan could require 100 Megabytes (Mb) of storage. The installation must require consultants to provide graphic data, such as maps and plans, in a format compatible with the installation's system. If the consultant has performed a translation in order to achieve compatibility, ensure that the translated graphics that may have become corrupted during the translation process are checked and edited before delivery.

c. In addition to ensuring compatibility in format, compatibility of magnetic medium is essential for data transfer. Floppy disks, mini disks, reel to reel tapes, cartridge tapes, compact discs, and WORM (Write Once Read Many) discs are a few types (Figure 5-3). Floppy disks, the most common storage medium, are also available in various sizes and storage densities. Each requires the use of unique hardware to store or retrieve data from the medium. It is essential that the installation ensure data be delivered from a vendor or consultant on a medium compatible with the installation's computer system. If the vendor cannot provide the appropriate medium, services are available for transfer of data between media. The vendor should be responsible for any data conversion costs incurred.

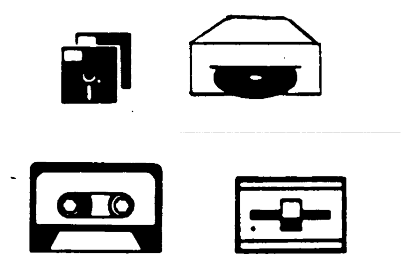


Figure 5-3
Media & Drive Types

5-4. Graphics and Tabular Data. The comprehensive planning process relies on data represented both in graphic form, such as maps showing building locations and footprints; and tabular form (areas known as attributes), such as lists of building numbers, functional uses, and square foot areas. The map shows an identification number for each building, which allows the planner to review the list of the uses of that facility. Although computer-based planning often works in the came way, that is, graphic and tabular data are separate data files which are only cross-referenced, it is most beneficial when the graphic and tabular data are digitally linked by the software. In the most sophisticated of systems, this allows the planner to display the map on the computer screen and merely "point" to the building (Figure 5-4) to retrieve data (Table 5-1) about that building. The tabular data can also be used-to sort the graphic data for analysis purposes. This is discussed further in Sections D and F. Furthermore, intelligent data bases link graphic and tabular data such that changes to either updates the other automatically.

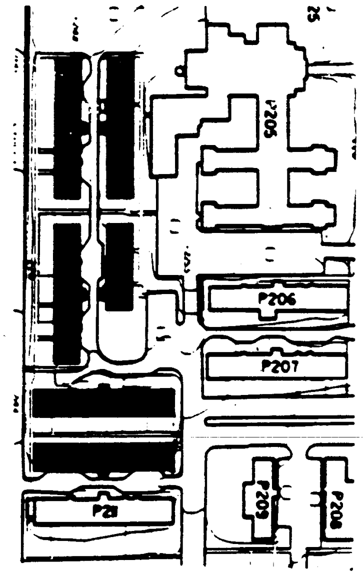


Figure 5-4
Site Plan

PREPARED 87 SEP 23 20:02 USAF REAL PROPERTY INVENTORY DETAIL LIST AS OF 87 SEP 22 RCN SE130-138

INSTALLATION GUNTER AFS

FAC NR	I N	T C	C D	C C	CM CD	A D	3H ?D	CATEGORY CODE	CATEGORY DESCRIPTION	AREA VACANT	AREA OUT-NLS	AREA OUT-LS	AREA TOTAL	UM	OTHER AMOUNT	UM	PAID	RECD	COST TO GOVT	EST VALUE	YR CN
08212	1	P	1	B		1		711144	FAM HSG APPR PFYS2				5824	SF	3	FA			46		41
08212	1	P	1	D		1	3L	711144	FAM HSG APPR PFYS2				[illegible]	SF	2	FA					41
08212	1	P	1	D		1	3U	711144	FAM HSG APPR PFYS2				1677	SF	1	FA					41
08212	1	P	1	X	8K			892233	OTHER FR SYS						4	EA			1		77
08212	1	P	1	X	8K			892125	A/C PLT, LS 5 TN				5824	SF	9	TN			2		64
08213	1	P	1	B		1		711144	FAM HSG APPR PFYS2				5156	SF	3	FA			46		41
08213	1	P	1	D		1	3L	711144	FAM HSG APPR PFYS2				3212	SF	2	FA					41
08213	1	P	1	D		1	4L	711144	FAM HSG APPR PFYS2				1944	SF	1	FA					41
08213	1	P	1	X	8K			892233	OTHER FR SYS						4	EA			1		77
08213	1	P	1	X	8K			892125	A/C PLT, LS 5 TN				5156	SF	12	TN			2		64
08214	1	P	1	A		1	3L	711144	FAM HSG APPR PFYS2				3224	SF	2	FA			41		41
08214	1	P	1	X	8K			892233	OTHER FR SYS						2	EA			1		77
08214	1	P	1	X	8K			892125	A/C PLT, LS 5 TN				3224	SF	6	TN			1		64
08215	1	P	1	B		1		711144	FAM HSG APPR PFYS2				5824	SF	3	FA			49		41
08215	1	P	1	D		1	3L	711144	FAM HSG APPR PFYS2				3315	SF	2	FA					41
08215	1	P	1	D		1	3U	711144	FAM HSG APPR PFYS2				1689	SF	1	FA					41
08215	1	P	1	X	8K			892233	OTHER FR SYS						8	EA			1		77
08215	1	P	1	X	8K			892125	A/C PLT, LS 5 TN				5824	SF	9	TN			2		64
08216	1	P	1	A	8K			612257	NO, SPECIFIED				6889	SF					94		41
08216	1	P	1	X	8K			892221	AUTO FR DTECTN SYS				6889	SF	1	EA			1		77
08216	1	P	1	X	8K			892222	MAN FR ALRM/I SYS						1	EA			2		77
08216	1	P	1	X	8K			892121	A/C PLT 5 TO 25 TN						20	TN			12		83
08217	1	P	1	A		1	3U	711144	FAM HSG APPR PFYS2				5824	SF	3	FA			48		41
08217	1	P	1	X	8K			892233	OTHER FR SYS						4	EA			1		77
08217	1	P	1	X	8K			892125	A/C PLT, LS 5 TN				5824	SF	9	TN			2		64

Table 5-1
Relational Database

5-3. Vector and Raster Graphics.

a. Graphic data is represented in two basic ways: vectors and rasters. It is important to understand their basic structure in order to see the advantage of each in any potential application. Any graphic, whether a simple facility site plan or a complex constraints and opportunities map, is composed of four basic elements: points, lines, arcs and polygons (Figure 5-5). Vector graphics refers to the representation which is most familiar. Points are represented by vertices (x,y coordinates), lines by pairs of vertices, and arcs and polygons by a series of vertices. Vector graphics can also easily represent three-dimensional data by x,y,z coordinates, z representing elevation. Drawings represented by vector graphics can be very accurate because vectors define specific, discrete points.

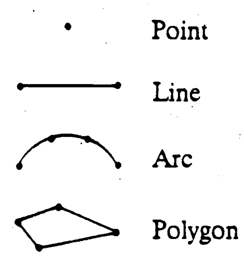


Figure 5-5
Basic Vector Graphic Elements

b. Raster graphics represents information quite differently. The system was adapted specifically for land analysis soon after its development and is, therefore, readily applied to comprehensive planning. Instead of points, lines, and polygons, rasters are the only basic graphic element employed. Rasters, also known as cells or "pixels," are squares of data defined by their column and row location, like a grid (Figure 5-6). An important feature of rasters is that they have size. The user can define the, size of the raster, such as one foot by one foot, 100 feet by 100 feet, or even one acre. The scale of the raster should relate to the level of detail and the scale of the source map.

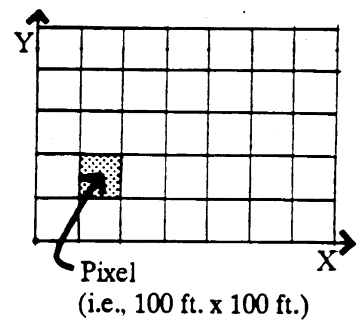


Figure 5-6
Rasters, Also Known as Cells or "Pixels"

c. The differences in vector and raster graphics are illustrated by the display alternatives of three features often found at military installations: a survey benchmark, an underground fiber optics communication line (Figure 5-7), and a weapons storage area. The benchmark in the field is perhaps a three-inch diameter metal plate set in concrete at ground level. It would be represented on a map by x,y coordinates in vector graphics and by one raster in raster graphics. If the raster size were large (10 feet by 10 feet, for example), the benchmark size and exact location would not be represented. Using vector graphics, the exact location of the benchmark is known, but additional tabular data would be required to record its size. The fiber optics line would be represented by a series of linear x,y coordinates or by a series of linear rasters. Its precise location could be well represented in vector graphics but would take on a "stepped" appearance in raster graphics. The weapons storage area would be represented either by a series of x,y coordinates which close a traverse or by a series of contiguous rasters; again, its exact boundary locations are better represented in vector graphics. clearly, vector graphics are more accurate in representing exact locations and sizes of mapped data and are, therefore, more appropriate for site planning, design, and engineering. However, raster graphics can be more efficient in data manipulation and are, therefore, more appropriate for land planning. In .addition, raster graphics are most beneficial in analyzing many maps together. The raster advantage is discussed further in Section F.

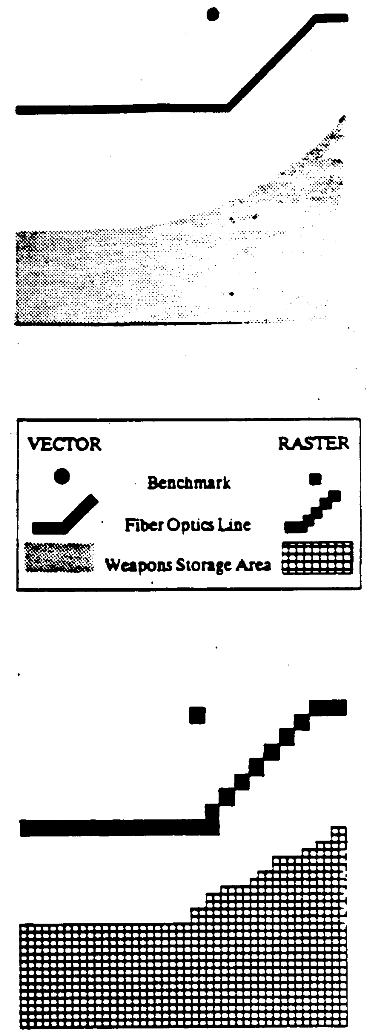


Figure 5-7
Vector/Raster Graphics

5-6. Hardware and Software Sources. For guidance in selecting and configuring specific computer hardware and software, refer to the Air Force's Integrated Graphics System (IGS) or to the Army's Intergraph computer system manual.

C. PHOTOGRAMMETRIC MAPPING DATA

5-7. Aerial Photographic Technology Overview.

a. Photogrammetric mapping refers to the method of mapping land cover using aerial photography. It supplements land surveys and can be accurate enough to fulfill the survey requirements. Generally, photogrammetric mapping (Figure 5-8) is much more cost effective than field surveys (Figure 5-9), particularly for large land areas such as military installations.

Figure 5-8
Aerial Photograph

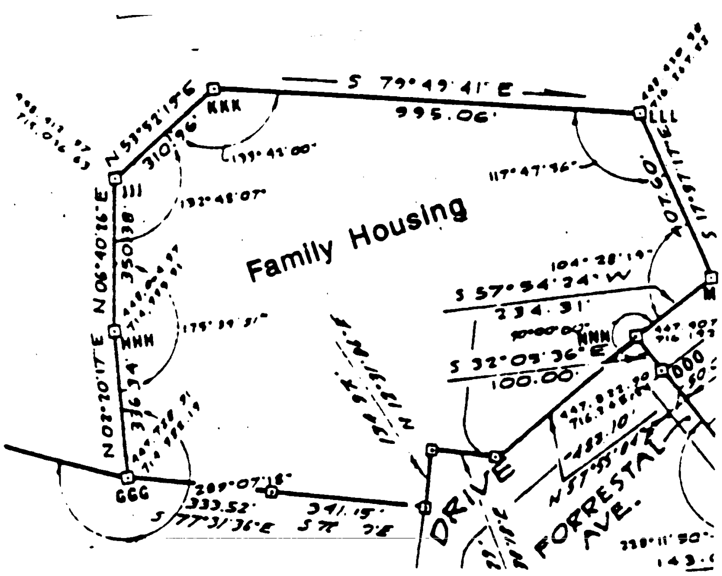


Figure 5-9
Land Survey

b. To create photogrammetric maps, highly accurate cameras are mounted in an airplane that flies over the candidate site. Figure 5-10 illustrates the flightline during photography of the study area. The scanner photographs in a row perpendicular to the flight line. Each flight line, or scene, overlaps by 60% to create stereo coverage, which can be viewed with a stereoscope in three-dimension. The size of the site and the scale of map and accuracy required determine the altitude of the plane. The plane is usually flown at low altitudes. The advantage of low altitude flights is accuracy and resolution of detail. A manhole cover might be discernible, for instance, at low altitudes For a large site, however, many photos would be required for total coverage using low altitude photography, which would increase costs. High altitude flights require fewer photos for the same coverage, but provide lower resolution of detail. When acquiring photogrammetric mapping services, evaluate the intended use of the map to determine the proper altitude.

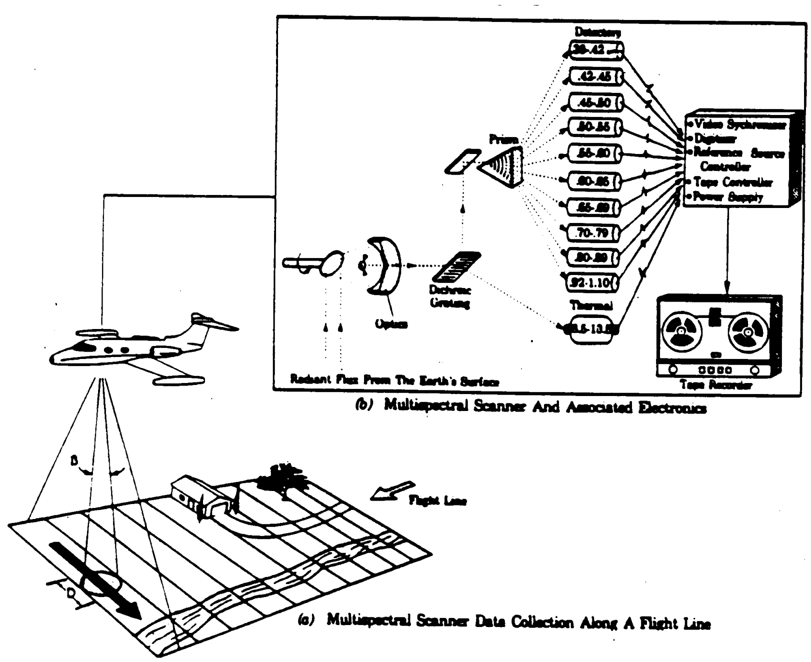


Figure 5-10
Photogrammetric Mapping Process
SOURCE: Introductory Digital Image Processing, John R. Jensen

c. The movement of the airplane, unlevel mounting of the camera, and curvature of the earth all contribute to distortion in aerial photography. Prior to mapping, a photo must be corrected for distortion through the process of rectification. Rectification involves relating discernible landmarks on the photo to their known locations on the ground, which are known as ground control points. Computer software digitally corrects the graphics to be geographically referenced.

d. Resultant photographs are traced to create the map. Tracing of the photo can be accomplished manually and digitally. In manual mapping, which creates a hard copy paper record of the photogrammetric data, features are hand traced from the photograph onto paper. Creating a digital form of the data, which is rapidly becoming standard practice, is accomplished by digitizing features from the photograph, i.e., tracing the features using an electronic digitizing table. The resulting maps in the computer are easily changed and updated and provide digital map products. As previously discussed, format compatibility is the key issue with digital data.

5-8. Mapping Standards.

a. Standards for mapping natural and man-made features are critical to ensure consistency in graphics. These standards should control graphic quality, including line types, line weights, colors, and types. For digital maps, they should also control "layer structure," that is, on which layers features are drawn in the CADD system. Both the Air Force and the Army have developed mapping standards which apply to CADD mapping as well as photogrammetric mapping.

b. The Air Force's San Antonio Real Property Maintenance Agency (SARPMA) has developed the Standard Specification Manual (SSM) for Digital Base Comprehensive Plan Mapping and Symbology, which has been adopted as the Air Force standard for use. The base planner developing base comprehensive plans or working with consultants to develop mapped data should ensure these standards are adhered to in producing manual or digital maps.

c. The Army has developed the Department of Engineering and Housing (DEH) Automation Graphics Guide, which guides the selection, acquisition, implementation, and management of Automated Graphics Systems (AGS). The post planner developing the post master plans or working with consultants to develop mapped data should first consult the guide for assistance in determining standards for producing manual or digital maps. A specific graphics standard manual for the Army is envisioned soon.

5-9. Mapped and Digital Data Available.

a. Many of the maps currently used in comprehensive planning were generated from aerial photography. Some are now available in both digital and hard copy form. The U.S. Geological Survey produces a wealth of mapped data in many scales, the Quadrangle ("quad") maps being the most widely used. They are generated from aerial photography and illustrate primarily land cover and topography. Quad maps, which cover 75 minutes (1:24,000 scale) (Figure 5-11) and 15 minutes (1:48,000 scale) (Figure 5-12) of land area, are available in digital form for most parts of the country. The topographic contour data is most readily available Quad data in digital form and is stored in digital line graph (DI-G) format. Digital elevation models (DEM) format files are also available for some areas. These files are created as three-dimensional files and can be used in digital terrain modeling (DTM) which is discussed in Section D.

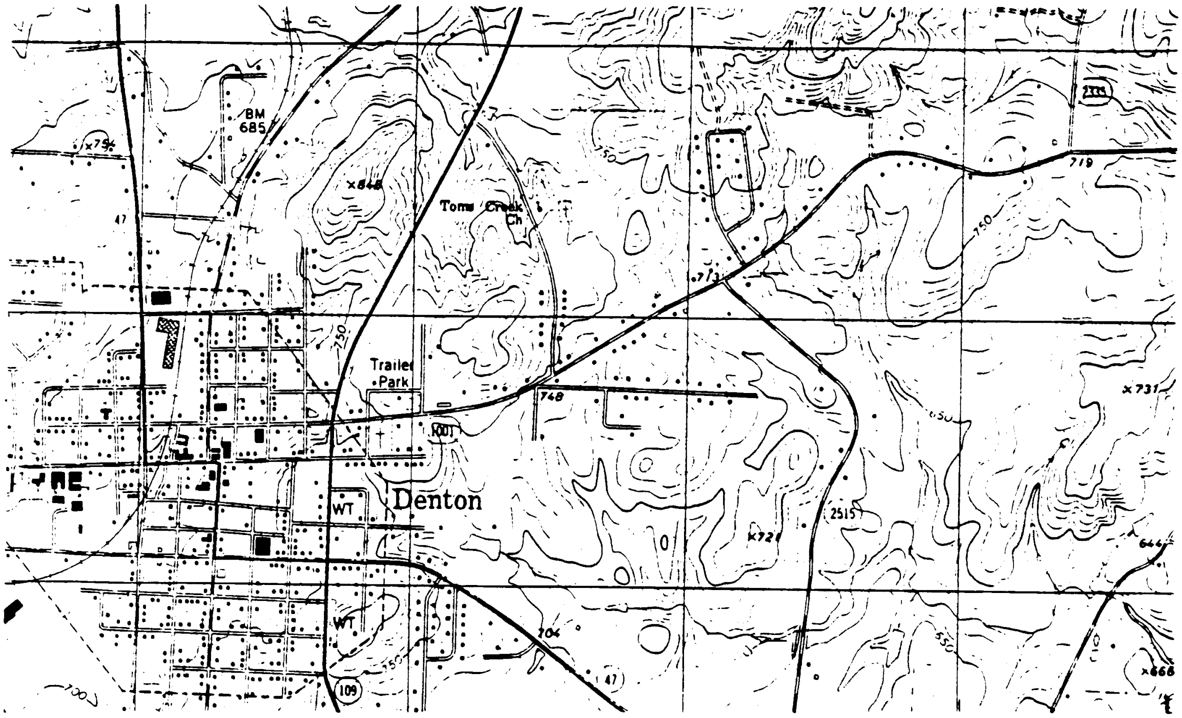


Figure 5-11 1:24,000

7 1/2 Minute Quad Map, USGS

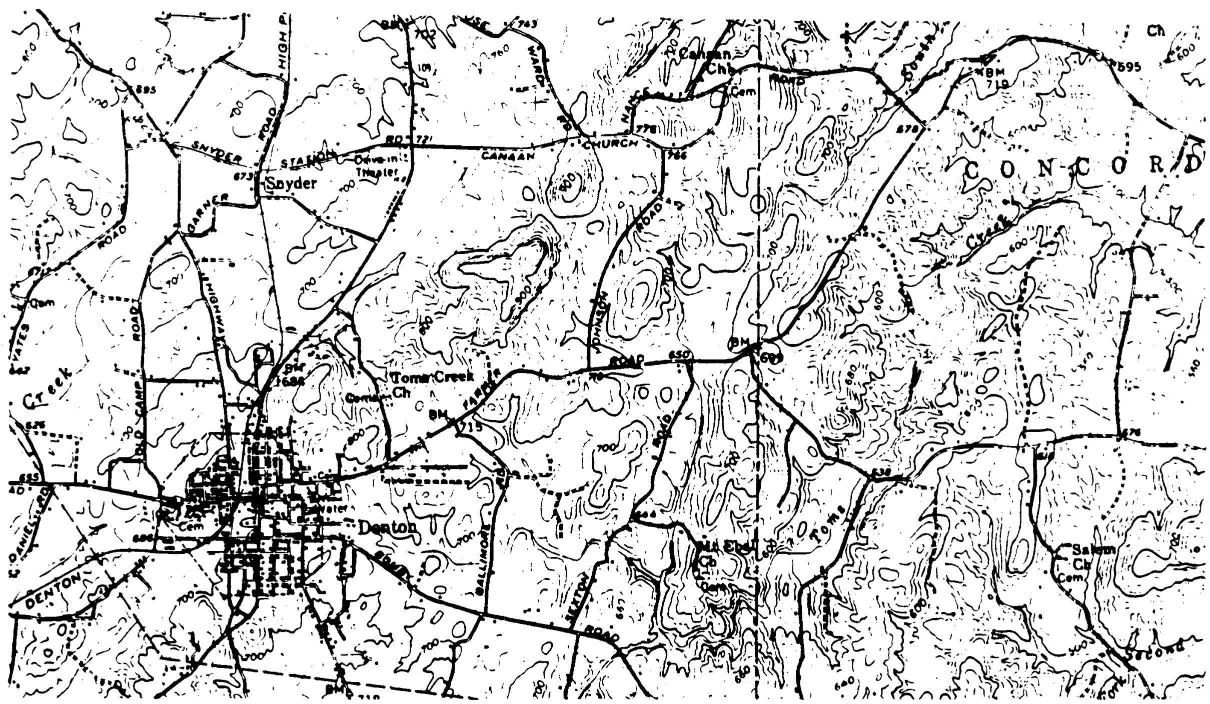


Figure 5-12 1:48,000

15 Minute Quad Map, USGS

b. Photogrammetric maps in hard copy form are available from numerous sources. Federal, state, and local agencies map extensively in various scales for their specific use and study. All nonclassified data is available to the public at usually nominal charges. Some valuable maps include soil classification maps from the Soil Conservation Service, orthophoto maps from the U.S. Geological Survey, state geological maps, state agricultural maps, and state highway maps. In addition, aerial photos can be custom flown and special photogrammetric maps of the installation generated. This is often accomplished, and highly recommended, when planning for major changes at an installation, such as those created by a proposed new mission (Figure 5-13).

Figure 5-13
Soil Conservation Service Map

5-10. Use in Comprehensive Planning.

a. Photogrammetric mapping has proven to be a useful resource m military installation comprehensive planning and is the primary resource for Air Force base comprehensive planning. These maps can be used to create a map of an installation or to update a base map. Photogrammetric maps at larger scales, that is, photographed at lower altitudes, can be used for detailed site planning in a particular part of the installation. Accurate photogrammetric maps can replace land surveys in most situations because they record all surface features. They are not, however, often useful in mapping underground features such as utility lines prior to taking aerial photos, unless these underground features are first marked or flagged on the surface. The major advantages of photogrammetric mapping include cost effectiveness, speed with which data can be obtained, accuracy of data, and ease of covering large land areas.

b. When obtaining photogrammetric mapping services from a consultant, the planner should take care to clearly identify the intended use of the maps, the required scale, and the level of detail required to ensure the product suits its purpose. In addition, various parts of the installation can be acquired at different scales and level of detail, such as the cantonment area at a scale of 1” = 20’ and the remaining area at 1” = 100’. The planner should also instruct the consultant concerning the contour interval to be mapped. In order to efficiently direct a consultant performing photogrammetric mapping, the planner should first grid off the installation on a base map illustrating the extent of coverage required at each scale.

D. COMPUTER AIDED DESIGN AND DRAFTING (CADD)

5-11. CADD Technology Overview.

a. Computer-Aided Design and Drafting (CADD) refers to the process of drawing and designing physical elements on a screen using a computer. In practice, CADD technology is being applied to a wide range of professional fields, including:

- Planning
- Landscape architecture
- Architecture
- Environmental studies
- Engineering
- Geography
- Geology
- Graphic design
- Medicine
- Biological research.

As the list suggests, CADD is a very flexible, broad-based technology with new applications constantly being developed. The following discussion is limited to comprehensive planning applications at military installations.

b. CADD systems must necessarily be very accurate to be used in the applications listed. Measurements must be as precise as possible and use of CADD has shown that precision is one of its strongest advantages over manual drafting. CADD systems use vectors to represent and store graphic data; as discussed in Section B, vectors provide the most accurate representation of a point, line, or polygon. A CADD drawing is composed of a combination of points, lines, and polygons which graphically represent mapped features. For an installation, these could include buildings, roads, utility lines, signs, landfill sites, training areas, entry gates, and future construction areas.

c. Considering the amount of different features that could be represented on one map on the computer, organization is essential to avoid confusion. CADD systems use a system of "layers" or "levels" on which features can be drawn (Figure 5-14). Roads are usually on one layer, buildings on another, and future conditions on still another. Utility lines might each be on a separate layer. It-is the same method used in manual mapping: draw different types of features on different drawing sheets. In the same way that sheets can be viewed or not viewed at any. time depending on the need, CADD layers can be turned on or off on the screen.

d. Tabular data is also a feature of CADD systems. The data usually represent attributes of the graphic data. For instance, a road drawn on a CADD system could be constructed of concrete, asphalt, gravel, or dirt; it could be four-lanes, two-lanes, or a one-way alley. It would also be a designated emergency route or a road with restricted access. This data is "linked" to the associated graphic element in one of two ways: on the screen next to the graphic element or in a separate computer file and "attached" to the graphic. The latter technique permits more attribute data to be stored and retrieved only when needed.

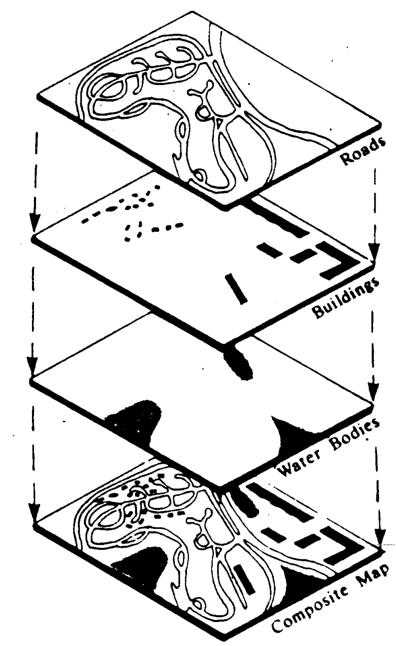


Figure 5-14
CADD Layers

5-12. Data Input

a. Graphic and tabular data can be entered into the computer in a number of ways, including digitizing maps, using digital photogrammetric maps, scanning maps, video digitizing maps, typing in data, and importing digital tabular data.

b. Digitizing is the most common input method. A paper map is placed on an electronic digitizing table and registered. A hand-held puck with buttons and a cross-hair target is traced over the features. As the map is traced, the computer converts the relative movement of the puck into vectors and stores the data in digital form. Digital photogrammetric maps are created this way by tracing the photographs, and can be purchased in their digital form. Digital census data is also available; census maps show streets and census blocks which are attached to tabular data about population.

c. Less often used means of entering data include scanning and video digitizing. Scanning methods use an optical scanner to "read in" the map. The level of accuracy achieved is dependent upon the resolution of the scanner. Since scanning produces only raster data, it is not acceptable input for CADD. Video digitizing is similarly unacceptable at this stage in development because of the low resolution of video technology as compared to the level of accuracy required for a map. These input methods are adequate for archive mapping only.

d. Tabular data can be typed into the computer and then attached to the graphic element. Tabular data already in digital form can be imported from other programs, such as spreadsheet or data base programs, and can then be attached to a graphic element or place on a drawing as text. Census data are the most common tabular data available for purchase and use in planning.

5-14. Data Attributes and Manipulation. The primary value of using attributes is to enable the planner to sort the graphic data (the map) using the tabular data (the attribute). Most CADD systems can display or highlight a group of graphic elements based upon a query. As an example, all installation buildings with a functional use of warehousing could be highlighted on the screen or drawn on the plotter. As mentioned, intelligently linked graphic and tabular data bases are much more powerful and more readily updatable. They can also be linked to another tabular data base related to construction costs or facility function needs.

5-13. Graphic and Tabular Output

a. The layer system used in CADD permits flexibility and enables the planner to output maps of any combination of elements, such as a map consisting only of wads and utilities. Tabular data can also be output in many forms, such as in a table of building numbers and square feet of area. This data could be derived from or provide input to the installation's real property records.

b. Output is usually in the form of plotted maps or digital data. Plotted maps can be created using pen plotters, electrostatic plotters, and laser plotters, all of which are available with color output (Figure 5-15).

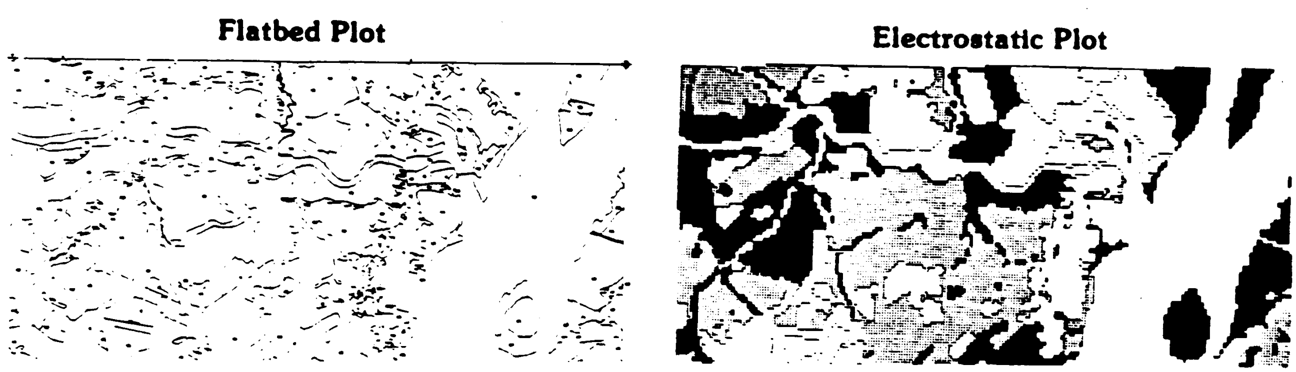


Figure 5-15
Pen Plot & Electrostatic Grid Plot of Land Use
SOURCE: Computer Graphics and Environmental Planning, 1983.

5-15. Planning Overlay Systems. The layer structure of CADD systems, some with hundreds of potential layers, provides an overlay system of organizing and manipulating data. As mentioned, any combination of layers can be turned on and off allowing the planner to. see relationships of different installation features. It works much like a pin-bar registered drafting system which aligns multiple drawing sheets.

5-16. Three-Dimensional CADD. One attribute which can be attached to a graphic element is its elevation. In the case of a ballfield's home plate, only one elevation would be stored by the computer. In the case of a building, the base elevation and the top of building elevation would be stored. Some CADD systems can use this data to create three. dimensional drawings of an area. Sections and elevations of areas can be easily drawn from this data, as well as can more complete isometric and perspective drawings. Digital terrain modeling, which is discussed further in Section G, is also possible with elevation data.

5-17. Application to Comprehensive Planning.

a. The installation planner can use a CADD data base in many ways to facilitate and improve comprehensive planning. Certain common functions can be easily accomplished, such as studying the use and condition of facilities or planning new utility line routes. In addition, opportunities and constraints for development can be analyzed and phasing of future MILCON projects can be planned. Census data, whether graphic or tabular, could be useful to military planners for programming housing needs at the installation because it provides information about housing and population in the adjacent urban areas.

b. The primary advantage of CADD for comprehensive planning is, the ease with which maps can be updated or changed. Its value also lies in the ability to conduct data queries, for instance, for use in site selection. It could be used to test the general costs of providing utility services to two sites. Planners can use this capability particularly when new missions are planned and old missions depart. The number of changes to the plan are significant and are revised often during the mission planning stages, making CADD almost a necessary tool.

c. Development of the data base involves a long process which often highlights the inadequacy of the manual maps available. In many cases, the data base is not usable for many months during its development, particularly for a large installation. Certain maps or portions of the installation can be input first, however, to make the system and data base available for immediate needs.

5-18. Remote Sensing Technology Overview.

a. Remote sensing refers to recording data from a distant location. Taking a picture with a camera is a simple example of remote sensing, but the term usually refers to a more specific process of aerial or satellite remote sensing. Aerial photography can be obtained in black and white, color, color infrared, or black and white infrared. The same photograph produced in each of these color options reveals different features about the land area covered. black and white often reveals soil wetness best, while color infrared reveals vegetation differences best. The color of choice is dependent, therefore, upon the intended use of the photograph. Planners can be trained in the special field of aerial photo interpretation in order to fully use the data available on a photo. With such training, very subtle land conditions can be discerned, even underground conditions such as location of utility lines, old landfill areas, and soil types. Even without the training, the photos are very useful in analyzing general environmental and development changes at an installation over a period of time.

b. Today, digital images are obtained by satellites that circle the earth and constantly record data. Satellites such as the U.S. Landsat satellite do not take actual photographs but, rather, record a numerical representation of various parts of the color spectrum (see Figure 5-16). Depending on

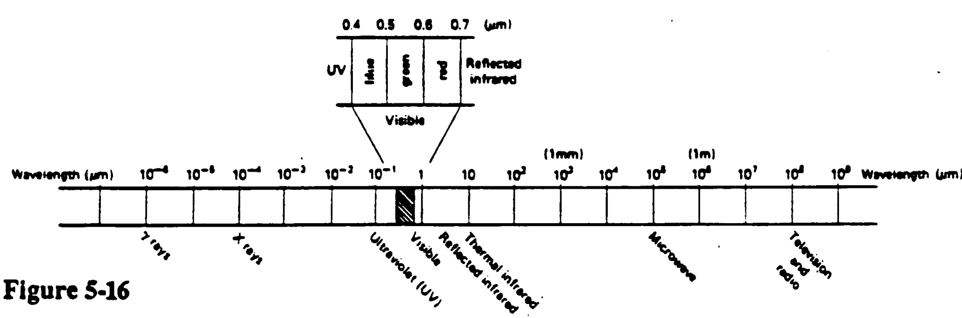


Figure 5-16

The Electromagnetic Spectrum

SOURCE: Remote Sensing and Image Interpretation, 1979.

the satellite, four or seven parts of the color spectrum are sensed and recorded as "bands." These data are recorded for each cell or pixel of predetermined dimensions which appears in the sensor's view window. The size of the pixel defines the image's resolution of detail. The dimensions of the land area covered by a single pixel determines the resolution of the data obtained. Remote sensing data is recorded in raster format, described in Section B. The output from this digital data is in' one of two forms: a composite photograph or a digital image. Composite photographs can be interpreted in the same manner as aerial photographs. Digital images can be analyzed and processed as described below (Figure 5-17).

Figure 5-17

Land Area Magnified

SOURCE: Introductory Digital Image Processing.

5-19. Photography and Digital Image Data Available.

a. Black and white, color, and color infrared photography is readily available at many scales from a variety of sources:

- Soil Conservation Service (SCS)
- Agricultural Stabilization Conservation Service
- U. S. Forest Service
- National Oceanic and Atmospheric Administration (NOAA)
- U. S. Geological Survey (USGS)
- National Space Technology laboratory (NSTL)
- State agricultural departments
- State highway departments
- Local municipal planning agencies
- Local aerial photography companies

Many of these photographs, particularly those in black and white paper print format, are very inexpensive to obtain. The SCS, which uses aerial photos to classify soil types, produces black and white photos covering much of the nation. The USGS, as discussed in Section C, uses photos to create quadrangle maps showing land cover and topography. Orthophoto maps are black and white photos in quadrangle format and are available in paper prints from the USGS. The NSTL produces color infrared, color, and black and white photographs in its National High Altitude Photography (NHAP) program. NHAP photos cover very large areas of land and are available in nationwide coverage (Figure 5-18). Film positives or paper positives of NHAP photos can be obtained in several scales. In addition, local aerial photography companies will photograph any site at a customer-specified scale and resolution.

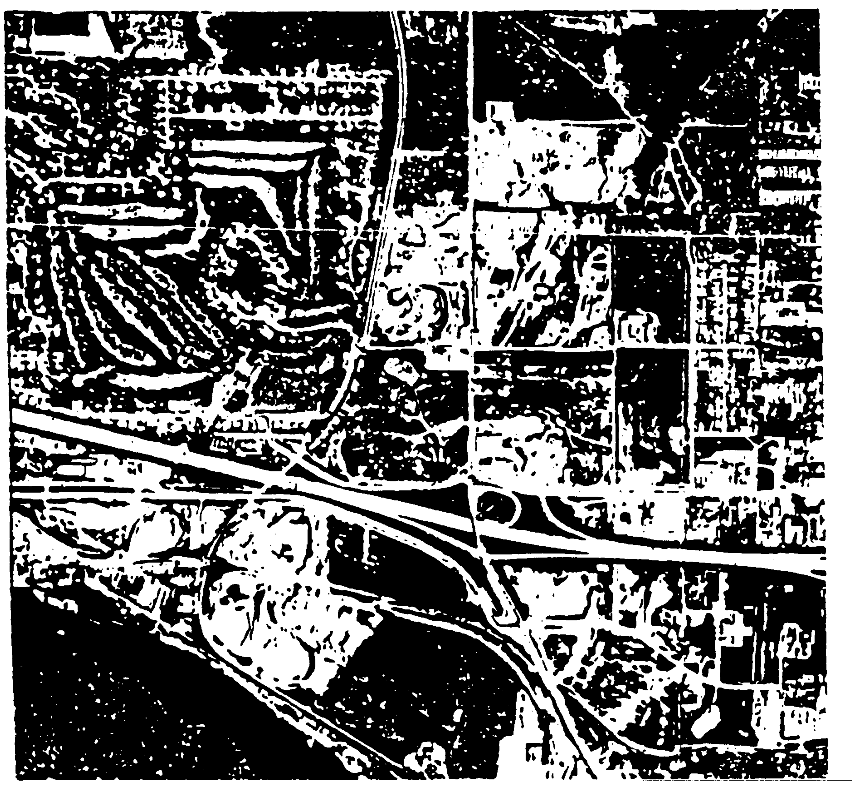


Figure 5-18
National High Altitude Photograph

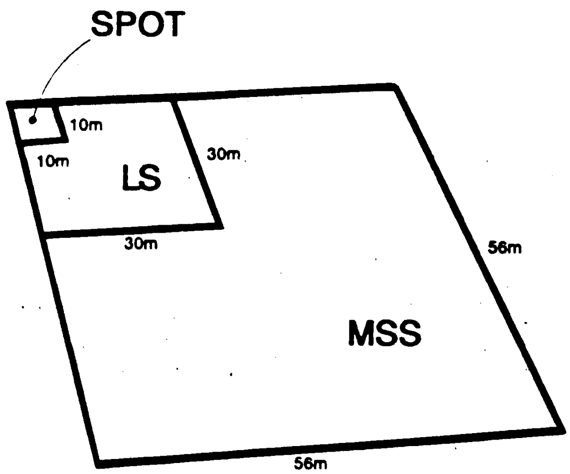


Figure 5-19

Diagram Illustrating the Spatial Resolution of MSS, TM, and SPOT digital Images

SOURCE: Introductory Digital Image Processing.

b. Digital images are also available from several sources. The Defense Mapping Agency (DMA) is the single source for all Department of Defense agencies in obtaining images produced by the U.S. Landsat satellite program as well as foreign programs. Two digital image products generated by Landsat of special significance in comprehensive planning applications are Multi-Spectral Scanner (MSS) images and Thematic Mapper (TM) images. MSS images provide data for four bands of the color spectrum in pixels of 79 x 56 meter resolution, while TM images covers seven bands at a resolution of 30 meters (Figure 5-19). Although TM data might appear to be inherently better, care should be taken in obtaining it because of its relatively high cost and vast data storage requirements. SPOT refers to the satellite and resulting digital image data produced by France. SPOT images cover eight bands of the color spectrum at a resolution of 20 meters in color and 10 meter pancromatic.

5-20. Image ProcessingTechnology Overview.

a. The value of digital images is that the data are stored as numbers and numbers' are readily manipulated by computers. Image processing systems are designed to analyze images to classify land cover types, soil types, and vegetation types, as well as other features. Color infrared images are used most often because the Infrared part of the spectrum, which is invisible to the human eye, Is particularly useful in discerning land features, particularly vegetation. Infrared photography was developed for military applications to discern the difference between camouflage green and real vegetation. The principle is based on the fact that different materials have distinctly different spectral signatures: a tank painted green actually "radiates" a different pattern of colors than green vegetation. Furthermore, pine trees reflect a different spectral signature than do oak trees. These differences are not readily discernible by the human eye, but a computer can determine differences by analyzing the numbers which represent the color reflection. The primary value of using digital images and an image processing system is, therefore, in classifying land cover types and patterns.

b. Digital images are characterized by distortion similar to that discussed in Section C. Distortion caused by the curvature of the earth, the flight path of the satellite, and light refraction in the atmosphere are corrected by rectifying the image to ground control points.

c. Several quality image processing systems are available. One highly sophisticated system, known as GRASS, was developed by the U.S. Army Corps of Engineers Construction Engineering Research Laboratory (CERL). Because it is public domain software, it is available at very low cost.

5-21. Use In Comprehensive Planning. Aerial photography and digital images are useful in comprehensive planning in several ways; foremost is as a basis for existing land use information. A series of photo images taken over time reveal the historic land use patterns at an installation and the changes that have taken place Old photos can be used to identify unrecorded landfill sites, burn pits, and other historic sites. Recent photos and images can be used to analyze sites to develop an optimum comprehensive plan for the installation. They can also be used to determine potential environmental and land use impacts of a proposed mission. In management of natural resources, the aerial photography can be used to monitor environmental and resource conditions. For instance, infrared photography is particularly useful in identifying specific vegetation, e.g., timber stands. Photo and image analysis is also applicable to land outside the installation boundaries. Adjacent lands are often affected by flight easements and explosive distance setbacks originating on the installation property. When determining the optimum location for a new runway or weapons storage area, the planner must often analyze adjacent land use conditions and can use photos and images to easily do so.

F. GEOGRAPHIC INFORMATION SYSTEMS (GIS)

5-22. GIS Technology Overview.

a. Geographic Information Systems refers to systems which store, manipulate, and output mapped information The primary difference between a GIS and a CADD system is that CADD is designed to map where features exist in a precise measurable format, whereas GIS is designed to map where features exist in a related format for overlay analysis. One CADD map could contain roads, buildings, and utilities with a series of attributes attached to each graphic element. One GIS map is usually thematic, meaning it represents one theme, such as soils (Figure 5-20). On that map, only one piece of information is stored for any given graphic element. A separate map is created for different thematic information. A GIS is designed to answer questions about relationships among maps, for instance: where are the installation's land areas that are most likely to erode? To answer that question, the planner might instruct the GIS system to find all land areas with these coincidental characteristics: slope greater than 20%, unstable soils, undeveloped with no vegetation, and downstream and within a major wash. The GIS system would take the individual maps of slopes, soils, land cover, and surface drainage, analyze them based upon the question, and produce a new map showing these areas.

Figure 5-20
GIS Thematic Map: Soils

b. GIS systems are available in both raster and vector formats. As discussed in Section B, raster graphics generally require less storage space and are much faster to process when comparing several maps. Vector graphics are more precise, but require considerably more time and complex programs to compare several maps.

5-23. Data Input. GIS data can be input just as CADD data can: by digitizing maps, obtaining digital maps, and scanning maps. If the GIS system is in raster format, the digital map is converted to rasters by a program usually available on the GIS system. One data input method involves using classified digital images, which arc remote sensing images that have been analyzed and classified into a thematic map using the spectral signatures of the land features. Land cover is a common classified image map used as input to a GIS data base (see Section E). In addition, data can be interchanged between CADD and GIS systems, even if one is in vector and one in raster format.

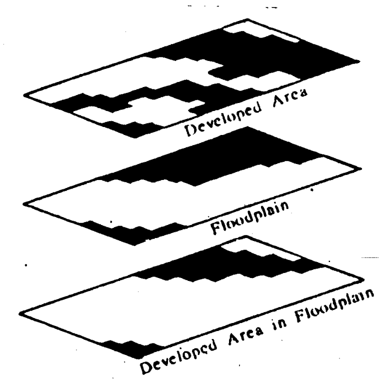


Figure 5-21
Coincidence Map

5-24. Data Analysis. A GIS system is designed to analyze mapped data in a variety of ways; several examples follow. First, two maps, one of developed area and one of floodplain, can be composited to determine coincidence of features, such as where flood plain overlaps existing developed areas (Figure 5.21). Second, data from one map can be sifted through a sieve of another map, much like gravel is sized through a sieve. One example of applying this concept is to take a map of land outparcels and subtract those areas from all other maps (Figure 5-22). Third, a GIS system can also automatically create new maps showing proximity to user defined features, such as areas within proximity of a weapons storage site (Figure 5-23). Fourth, neighborhood operations can also be performed on GIS maps, whereby a cell or pixel “looks around" at its neighbors to create a new map. Creating a slope map from an elevation map is a classic application of a neighborhood operation, because the slope of any area is based upon the relationship between that area's elevation and its neighbors' elevations.

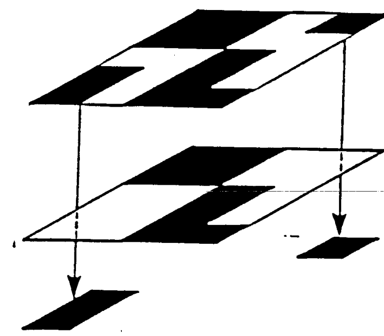


Figure 5-22
Sieve Map

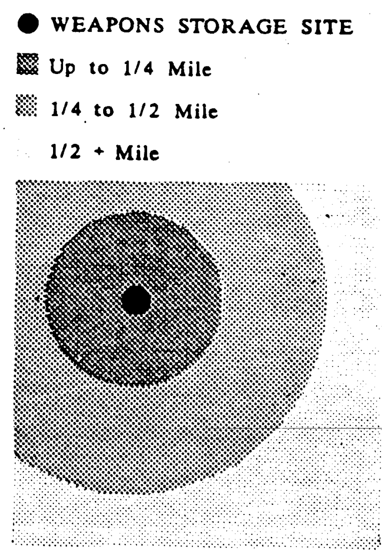


Figure 5-23
Proximity Map

5-25. Graphic and Tabular Output.

a. Output for GIS analysis can be in the form of maps or tables of statistical data. Statistical output generally documents the quantity of land areas on a map, such as the number of acres of transportation and utility facilities that live within a study area (Figure 5-24). Graphic output consists of maps. These can be maps of existing conditions, such a land use map, or analysis maps, such as an opportunities or constraints map.

VALUE	POINTS	ACRES	%	DESCRIPTION
0	1421470	316137.906	0.00	Background
1	9834	2187.102	0.47	Primary Highways
2	23405	5205.321	1.12	Secondary Highways
3	6675	1529.014	0.33	Railroads
4	9625	2140.843	0.46	Power Transmission Lines
5	2050	455.924	0.10	Pipelines
6	2039890	453675.812	97.52	Study Area
TOTALS	2091680	465194.031		

Figure 5-24
Transportation Histogram

b. Graphic hard copy output is usually in the form of plotted maps or digital data. Plotted maps can be generated using pen plotters (Figure 5-25), electrostatic plotters, laser plotters, and ink jet printers, all of which are available in color.

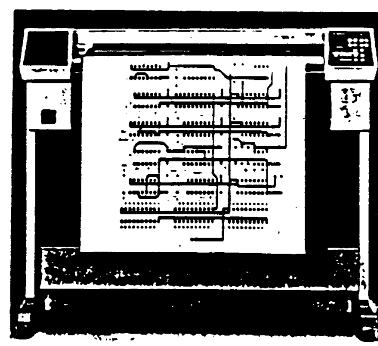


Figure 5-25
Pen Plotter

5-26. Application to Comprehensive Planning.

a. The planner can use a GIS system to assist in analysis and planning of the installation. Environmental analysis, such as slope analysis or constraints analysis, can easily be accomplished to assist in siting new facilities. A GIS System can also be used to create the proposed future plan for the installation by using its analysis capabilities.

b. Using a GIS system is beneficial particularly because installation planning is ongoing, requires regular and constant updating, and can require quick, dramatic changes as new missions come and existing missions leave. A GIS system makes it easy to generate "what if" scenarios efficiently, which promotes better planning.

c. If all the systems described thus far were to be used in the comprehensive planning process, they would typically be used as follows:

- First, **remote sensing** would be used to collect general planning data about existing conditions.
- Second, **image processing** would be used to analyze and classify the remotely sensed image.
- Third, other data would be **digitized and used In a GIS** along with the classified image to conduct opportunities and constraints analysis. The GIS analysis would then be used to accomplish general land planning.
- Fourth, as a specific project was planned based upon the land use plan, **photogrammetric mapping** of the site would occur.
- And, fifth, this detailed mapping would be used in a **CADD** system for site-specific planning, design, and engineering.

5-27. Visual Simulation Overview.

a. Visual simulation is a technique of showing what an area would look like after a proposed action occurs, such as construction of a large building or massive regrading of topography. The purpose of these simulations is to analyze the visual impact of the proposed action. This technique can be particularly valuable when proposed changes to the installation have visual impact to neighborhoods adjacent to the installation. Visual simulations are useful in showing impacts accurately and objectively and are defensible techniques in public hearings.

b. Visual simulations can be accomplished manually and digitally. Manual techniques can involve altering photographs, such as painting a proposed transmission line on a photograph (Figure 5-26). Digital techniques often involve using digital terrain models (DTMs) of existing and proposed topography (Figure 5-27). DTMs use elevation data to create "wire-frame" drawings of the landscape terrain. CADD systems often have a DTM component.

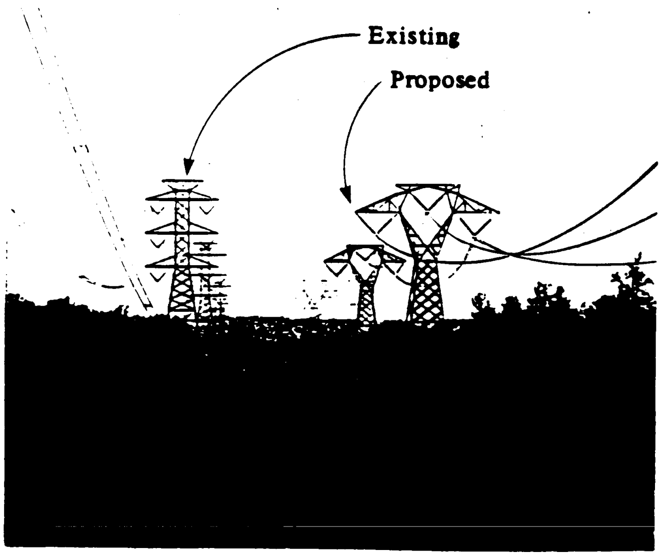


Figure 5-26
Visual Simulation Model (Manual Technique)

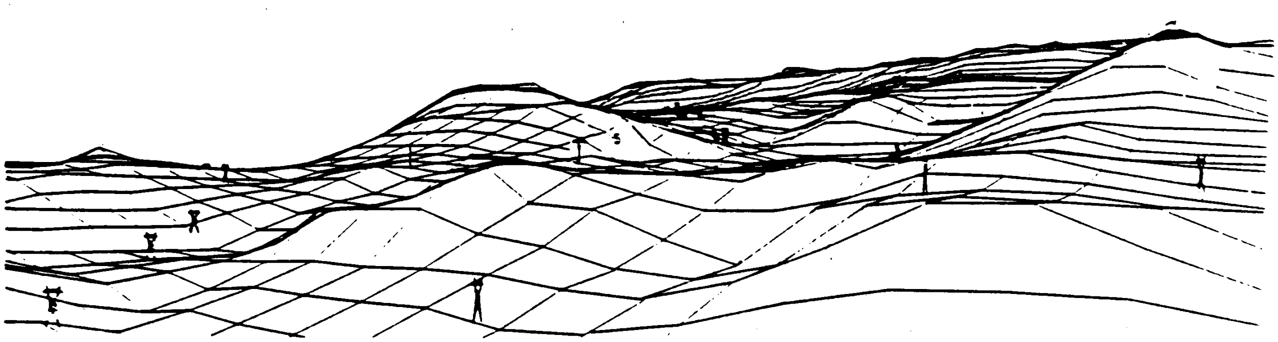


Figure 5-27
DTM with Proposed Transmission Line

5.28. Environmental Modeling Overview.

a. Environmental modeling involves modeling, or simulating, environmental conditions which cannot be mapped or are too difficult to map. Two examples are archaeological locations and soil erosion potential. Locations of actual archaeological sites can be found efficiently through a predictor model based on site sampling surveys. Soil erosion potential cannot be located in the field because it is a condition that has not yet occurred. Given slope, land cover, and soil type data, we can model where this condition potentially might occur.

b. Environmental modeling can be accomplished manually or digitally. The planner must first design the model formula, i.e., which mapped data combine to model the condition. Manually, these maps can be overlain at the same scale on a light table or combined in a GIS system. Environmental modeling is usually most valuable when significant changes are proposed to occur at an installation and will likely affect large land areas. These are the conditions under which impacts to the environment are likely and must be analyzed.

5-29. GIS and CADD Mapping Data Sources.

a. Remotely Sensed Data Sources:

- Earth Observation Satellite Company (EOSAT)
  - Landsat Data
- Spot Image Corporation
  - Spot data
- EROS Data Center and National Cartographic Information Center (NCIC)
  - Aerial photography
  - Digital Elevation Models (DEM)
  - Digital Line Graphs (DLG)
  - Land use and land cover
  - National geographic names data

b. National Cartographic Information Center (NCIC) provides eartographic products from the following federal agencies:

- U.S. Forest Service
- Bureau of Land Management
- Water and Power Resources Service
- U.S. Geological Survey
- Bureau of the Census
- Central Intelligence Agency
- National Oceanic and Atmospheric Administration
- National Ocean Survey
- Corps of Engineers
- Federal Highway Administration
- Federal Power Commission
- Tennessee Valley Authority
- Mississippi River Commission
- International Boundary Commission
- Library of Congress
- Agricultural Stabilization and Conservation Service
- Soil Conservation Service
- National Archives and Records Service
- National Aeronautics and Space Administration
- Defense Mapping Agency

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